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Research Article

Evaluating the Impact of Semi-Immersive Virtual Reality on Urinary Catheterization Skills, Motivation, and Satisfaction in Nursing Students

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Abstract

Aims: The basic core skill and competency nursing students need is urinary catheterization. Semi-immersive virtual reality (SIVR) based research innovations based on situational learning theory have not been widely used to improve student proficiency. This study aimed to analyze the skills, motivation, and satisfaction of nursing students with urinary catheterization learning before and after the implementation of SIVR.

Methods: The study was designed as a pre-test and post-test randomized controlled trial (RCT). The study population was undergraduate nursing students at the Bhakti Wiyata Health Sciences Institute, Kediri. The SIVR group (n=52) received catheterization skill practice through SIVR, whereas the control group (n=52) was given 2-dimensional video learning. The results obtained were catheterization skills, motivation, and satisfaction, which were evaluated before and after the intervention. In this study's statistical test analysis, the chi-square test and the independent t-test were used.

Results: Post-test results showed a significant improvement in catheterization skills in the SIVR group (M = 92.74, SD = 1.05, p = 0.032) compared to the control group (M = 79.95, SD = 1.51), a significant improvement in motivation in the SIVR group (M = 6.48, SD = 0.54, p = 0.010) compared to the control group (M = 5.23, SD = 0.49), and a significant improvement in satisfaction in the SIVR group (M = 3.49, SD = 0.83, p = 0.024) compared to the control group (M = 2.88, SD = 0.52).

Conclusion: SIVR simulation and video learning can improve nursing students' skills, motivation, and satisfaction. SIVR program learning can be recommended as an intervention for the effectiveness of the quality of practical learning following current technological advances and in the long term it is expected to improve graduates' practical skills.

Keywords:
Catheterization, Motivation, Nursing Education, RCT, Satisfaction, Semi-Immersive Virtual Reality, Skill, Virtual Simulation,

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Jurnal Keperawatan Komprehensif
Volume 10 Issue 5 October 2024

INTRODUCTION

Urinary catheterization can improve comfort in individuals with urinary disorders and is one of the nursing interventions of choice for urological disorders (1). However, the procedure of catheterization and care of patients with catheters that are not appropriate and correct will result in fatal problems including pain, injury and infection (2). In nursing practice and health services, preventing problems is a crucial sign (3), Although, in nursing education, the competence of urinary catheterization has been widely taught through practical learning, many students still do not have the opportunity to achieve competence according to the expected competency targets, both knowledge and skills, especially in urinary catheterization observed in recent years (4, 5).

Previous studies have stated that many nursing graduates have difficulty in fulfilling the competency standards for urinary tract catheterization procedures with an average low urinary tract catheterization skill score of 61% (6). Therefore, nursing students need to understand how to accurately provide catheterization for urine using sterile techniques and understand cognitive, affective, and psychomotor (5). It is expected that nursing clinical educators should be able to effectively use laboratory and clinical models to improve competencies and expertise in urinary catheterization since it is expected to allow nursing students to learn properly in the clinical setting (7)(4)(5). Literature studies related to in-depth urinary tract catheterization procedure competency for teaching methods were still limited (6)(8).

Currently, there is still very limited consensus in nursing education regarding the use of virtual-based cognitive-affective learning strategies (9). Based on the problems discussed above, an effective learning technique is needed to follow the creation of technology for education by using psychomotor, cognitive, and affective learning theory (PCA) using immersive virtual reality (10). PCA is applied to multimedia-based learning. The cognitive, affective and psychomotor reactions influence the outcomes of learning (11, 12). There are three types of IVR systems (13), including non-immersive VR, semi-immersive VR and total-immersive (IVR). SIVR and IVR provide a comprehensive experience (13)(14). SIVR simulation with student learning scenarios using 360-degree reality cameras to train various skills and can increase comfort (13). With technological innovation, settings may be considered set and performance effortless to observe and record using the virtual world for situational learning, giving users the feeling of being present or 'there' and getting the opportunity to learn in the same situation (11)(15). Based on instrumental costs, virtual simulation has a lower cost-utility than manikin-based simulation and can increase motivation, satisfaction and knowledge among nursing students (16).

The application of SIVR as a replacement for conventional approaches to teaching is not supported by evidence, and studies on the topic were limited. Uniquely, there is still a lack of review of virtual learning, especially SIVR, in nursing education among nursing students (15)(13). Despite advances in nursing education, many students struggle with urinary catheterization skills. Virtual reality offers a promising solution, but its use in nursing education remains underexplored. Therefore, learning using SIVR needs to be considered. The study was carried out to evaluate the impact of semi-immersive virtual reality on urinary catheterization skills, motivation, and satisfaction in nursing students. This will increase the use and acceptance of SIVR in nursing students.

METHODS

Design and Participant

The study conducted a randomized controlled trial (RCT) including a pre-test

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Jurnal Keperawatan Komprehensif
Volume 10 Issue 5 October 2024

and post-test design. The study's population of this study includes students from the undergraduate nursing study program at the Bhakti Wiyata Institute of Health Science Kediri. Inclusion criteria were students aged ≥ 20 years, who never acquired urinary tract catheterization skills, and who were in their second year (3rd and 4th semester). Exclusion criteria were students who were unwilling to participate and were on academic leave.

The G-Power application was used to calculate the number of samples for this investigation, with an α error probability of 0.05, a power of 0.80, and an impact size of 0.71 (17). A minimal size of sample anticipated by the researcher was 86 students. To avoid the error rate or unwillingness to be a respondent, 20% sampling was taken so that the total sample was 104 respondents. In this study, the student samples were randomly allocated to the SIVR group (52 participants), and the control group received 2-dimensional video learning (52 participants) applying simple randomized. Random sampling was performed using a 1:1 distribution ratio generated by computer assignments.

Instruments

Assessment of urinary tract catheterization skills measured utilizing the standard operating techniques (SOP) approved by the Indonesian Nurses Association and implemented at Gambiran Hospital, Kediri. The questionnaire to assess motivation was translated and modified by researchers from the learning motivation techniques questionnaire (18). The learning motivation items consist of four subscales: (1) four items on intrinsic goals; (2) four items on extrinsic goals, measuring the level of participant task participation for value, rewards, performance, and competitive reasons; (3) six items on task value, measuring how interesting, important, and useful the course is for participants and how motivating they are to continue learning; (4) eight items on participant self-efficacy towards their skills (19). Validity and reliability were conducted on 20 first-year students, and the average value of sig r = 0.001 and Cronbach alpha = 0.892. Learning satisfaction using questionnaire items was translated from previous research (20). Each part is assessed on a 5-point Likert scale (strongly disagree to agree), with higher ratings implying more satisfaction with the learning process. The results of the validity and reliability tests showed a Cronbach alpha value = 0.763.

Intervention and Control Group

The SIVR program's instructional materials and scripts were created by the research team. The SIVR program application is built using Unity 3D and C# using computer-aided assembly. The virtual reality program is designed and developed using 3ds Max. The SIVR program scenario is based on standard operating procedures and performance protocols for urinary tract catheterization activities, which consist of the preparation, action, and assessment phases. When applying SIVR, students recreate actual situations and carry out the duties assigned to every scenario by making appropriate judgments and following the required processes.

The investigators provided a briefing about the study's objective, advantages, and experimental methods. Everyone who joined part signed an informed consent form and was told that they could withdraw from the study without penalty. Before the implementation of the experimental activities started, a professional lecturer with a background in nursing education led a 20-minute conversation after a 10-minute briefing and explanation for all participants. Next, SIVR group participants learned the procedure through SIVR scenario studying, while control group members were monitored through a 20-minute standard two-dimensional video.

Data Collections and Procedure

SIVR group members controlled the SIVR system while standing in a designated room. The research team assisted and guided participants on how to use their

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Jurnal Keperawatan Komprehensif
Volume 10 Issue 5 October 2024

head-mounted VR (HTC; VIVE Focus Plus) and start the virtual reality experiences when they were ready. Participants completed the simulation procedure at their own pace. On average, the procedure will take around twenty minutes to complete. All participants were watched and preserved throughout the trial, and VR operating protocols were provided as needed, and ensured that the experiment ran successfully. If participants became uncomfortable or disturbed during the experiment, they had the decision to stop participating. Data on participant demographic variables such as age, gender, GPA average, visual impairment, and VR experience was acquired at the start of the study.

Ethical Consideration

The Strada Indonesia Institute of Health Sciences Research Ethics Committee approved the research (IRB No. 001412/EC/KEPK/I/06/2024). All participants in this study provided written informed consent, and all participant information will be kept confidential. The consent forms were collected after the researcher explained the purpose and research and ensured data confidentiality. Identification was encrypted to keep the identity of the participants confidential. Participants were informed that they might leave the study at any moment and were given the chance to object if the VR simulation made them uncomfortable.

Statistical Analysis

Data collected from the questionnaire were imported into SPSS (version 27; IBM Corp) for analysis. A frequency distribution table is used to explain participant demographic data and to explain measurement findings for skills, motivation, and satisfaction. Statistical analysis employing the Chi-square test to determine the homogeneity of the SIVR and control groups, including demographic data and covariates assessed in the study sample. The skills levels, learning motivation, and learning satisfaction of the SIVR and control groups were analyzed using an independent t-test. The difference between the two groups was examined using analysis of variance for repeated measures (ANOVA). The statistical analysis was regarded as significant if $P < 0.05$ in this research.

RESULTS

The control group had a mean age of 19.68 years and a standard deviation of 0.41. The SIVR group had a mean age of 19.56 and a standard deviation of 0.37. Most of the sex was male (60.42%). Most participants (64.58%) reported no previous exposure to virtual reality technology. Similarly, most participants indicated no visual impairment. Table 1 shows the participants' demographic characteristics. At baseline, there were no significant changes observed between the SIVR and control groups.

Table 1. Comparisons of sociodemographics of participants in both groups

Variable category	Control Group n=52, n (%)	SIVR Group N=52, n (%)	P-value
Age, mean (SD)[a]	19.68 (0.41)	19.56 (0.37)	0.725
GPA, mean (SD)[a]	3.14 (1.86)	3.18 (2.15)	0.584
Sex[b]			
Male	20 (38.5)	21 (40.4)	0.816
Female	32 (61.5)	31 (59.6)	
Experience with VR[b]			
No	35 (67.3)	34 (65.4)	0.417

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Jurnal Keperawatan Komprehensif
Volume 10 Issue 5 October 2024

Yes	17 (32.7)	18 (34.6)	
Visual impairment			
Minus eyes	16 (30.8)	15 (28.8)	0.792
Normal eyes	36 (69.2)	37 (71.2)	

Note: n= number; SD= standard deviation; GPA= grade point average. [a]Independent t-test; [b]Chi-square test.

Table 2 indicates the average pre-test scores for catheterization skills, motivation, and satisfaction between the SIVR and control groups showed no significance. The SIVR group showed a significant improvement in catheterization skills, motivation, and satisfaction ($p<0.05$) after the intervention, according to an independent sample t-test.

Table 2. Comparison of score between intervention and control group (n=104)

Variables	Control Group N=52, n (%)	SIVR Group N=52, n (%)	*P-value
Skill, mean (SD)			
Pre-test	72.24 (1.47)	72.78 (1.54)	0.206
Post-test	79.95 (1.51)	92.74 (1.05)	0.032
Motivations, mean (SD)			
Pre-test	4.22 (0.45)	4.35 (0.48)	0.522
Post-test	5.23 (0.49)	6.48 (0.54)	0.010
Satisfaction, mean (SD)			
Pre-test	2.75 (0.47)	2.76 (0.49)	0.123
Post-test	2.88 (0.52)	3.49 (0.83)	0.024

Note: n= number; SD= standard deviation; *Independent t-test.

DISCUSSION

This RCT study maintained that SIVR urinary tract catheterization increased nursing students' skills, motivation, and satisfaction. The results of this investigation are consistent with previous studies done by Park et al. (21). According to previous research, it was found that participating students stated that they were very satisfied with the IVR scheme and had a pleasant learning experience that had a positive impact on them (7). Other results, however, showed that self-confidence and learning satisfaction did not significantly differ between the SIVR group and the control group. The findings of this study differ from those of the other research. However, the VR group showed greater improvement in urinary catheterization skills (22). The SIVR program, as an effective and beneficial teaching instrument, is ideal for second-year nursing students' learning, greatly improving their abilities (22). Our literature evaluation, as well as Yoon and Lee et al., (22) covered research that attempted to strengthen theoretical knowledge and develop procedural abilities through educational interventions. There is potential for IVR to improve the effectiveness of procedural skill commands because it provides a realistic situation that is very similar to the real clinical environment, thus helping students remember the steps in urinary catheterization skills. However, in the context of teaching theory, the acquisition of knowledge and skills depends on individual understanding and memorization ability (23).

Previous research has shown that IVR significantly improves knowledge scores among nursing students (24). In addition, the results of a systematic review stated that immersive technology and virtual

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Jurnal Keperawatan Komprehensif
Volume 10 Issue 5 October 2024

reality are mostly used to teach the most widely used clinical skills, which were analyzed from 29 papers (25). The findings of this study indicate the present state of research and support the effectiveness of IVR as a technology for ideal instruments for learning to improve the skills and satisfaction of healthcare students. A study in Taiwan found that compared to traditional learning, students who learned using Spherical Video-based Virtual Reality (SSVR) had higher levels of motivation and satisfaction. This shows that the potential of VR technology is powerful in improving nursing students' learning performance. (26). The basic principle of VR simulation training is that knowledge acquisition occurs based on clinical experience. The VR simulation develops nurses' cognitive skills that demonstrate clinical scenarios that are very comparable to actual clinical circumstances. So, this technique enables nursing students to pick up information that is theoretical as well as practical with validation by combining past learning experiences. Thus, it is not surprising that IVR simulation can have an impact on students' cognitive, affective, and psychomotor skills, thereby increasing student motivation and satisfaction in learning (27). Therefore, it can be said that further studies should confirm these results. In addition, planning teaching to appropriate students will make the process more effective and efficient. From this point of view, this study has provided important evidence to the literature.

The study's scope was confined to nursing students at one institution, which is one of its limitations, so we acknowledge that the findings of this study cannot be generalized to other nursing students who use IVR simulation programs. In addition, SIVR simulation is new to students so many students have difficulty adapting during the learning process where the simulation is limited to one session. Further investigation is needed to expand the number of college and nursing students and increase the number of meetings and duration of simulation sessions for training so that students become accustomed to VR-based learning. In addition, it is necessary to assess the potential long-term impact of SIVR among nursing students.

LIMITATIONS

The study was conducted at one institution, so its results cannot be generalized to other educational institutions. The duration of the SIVR simulation was short, only one session, thus limiting the depth of students' insights. So, it is recommended that further researchers conduct similar studies with a longer time and several meeting sessions so that they will increase students' learning motivation better than these findings.

CONCLUSION

The present article describes the application of SIVR simulation to teach nursing students about urinary catheterization. Our research findings describe significant improvements in student performance skills, motivation, and satisfaction compared to students who did not use the SIVR simulation program. Our study demonstrates the effectiveness of SIVR simulation as a teaching method for nursing students, which facilitates skill improvement and provides a learning experience that closely resembles a realistic clinical situation with problem-solving abilities in virtual scenarios. We recommend that nursing institutions integrate SIVR simulations into their curricula to enhance student engagement and improve practice skills.

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Jurnal Keperawatan Komprehensif
Volume 10 Issue 5 October 2024

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