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Research Article

The Effect of an Immersive Virtual Reality on Nasogastric Tube Feeding Skills and Self-efficacy Among Nursing Students

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Abstract

Aims: Video-based learning as a preparatory method for nasogastric tube feeding is prevalent among nursing students. Interestingly, there is a growing interest in incorporating immersive virtual reality (IVR) simulators into educational practices. Aims of this study to examine the effect of an IVR on nasogastric tube feeding skills and self-efficacy among nursing students.

Methods: A quasi experimental study with trial two-arm. 108 nursing students were recruited from two universities in Central Java. The IVR group (n=54) received nasogastric tube feeding skill practice through IVR, whereas the control group (n=54) watched a 15-minute video. Both groups received online nasogastric tube feeding lectures. The outcomes were nasogastric tube feeding skills and self-efficacy, with evaluated immediately before and after interventions. The Chi-square test, and independent t-test were employed.

Results: The results indicated a considerable improvement in nasogastric tube feeding skills in the IVR and the video groups, with significant differences found between the two groups. Additionally, the group that utilized IVR demonstrated higher scores in self-efficacy compared to the group that used video, with statistically significant differences reported between the two groups.

Conclusion: The IVR education and video enhanced the skills and self-efficacy. IVR can be recommended as an intervention to improve the quality of long-term education nursing care through technological advances.

Keywords:
Immersive virtual reality, nasogastric tube, self-efficacy, skill.

INTRODUCTION

Nasogastric tube feeding is the most commonly used method of enteral feeding, mainly if feeding will be used within the procedure time, which should be relatively short and accurate (1). Notably, the skills of nurses in nasogastric tube feeding and further care are essential to ensure the safety of patients (2, 3). Compliance with standard protocols in managing nasogastric tube feeding is crucial in the quality chain of health and safety delivery remains a significant challenge (2). El-Meanawi et al, 2017 revealed that 62% of nurses in Egypt have unsatisfactory knowledge of nasogastric tube feeding (4). Moreover, nurses' skill of nasogastric tube feeding is not good enough, with some unsafe practices (1, 2). In Indonesia, professional nurses are taught standard nursing protocols for nasogastric tube feeding by the curriculum of Nursing Councils (5). Interestingly, a lack of research has explored the nasogastric tube feeding skills among nursing students in Indonesia. Based on the above problems, effective learning methods are needed to follow the

development of learning technology by following cognitive–affective learning theory to solve problems.

Conventional educational approaches have been criticized for their inability to adapt to climate change-related modernization (6, 7). Immersive Virtual reality-based learning (IVR) has gained popularity, allowing users to create IVR environments and facilitating efficient and effective student learning applications. Students can partake in the learning process anywhere, including at home, because IVR-based learning is not time- or location-dependent (7). IVR can practice indefinitely with feedback and self-correction until they acquire special skills (8), thereby personalizing the learning process (9). This fact, coupled with the low cost of clinical implementation, suggests that virtual reality can be a competitive addition to extant learning approaches (9, 10). Several studies examine the efficacy of IVR in enhancing learning outcomes (11), particularly in the nursing field (12). Numerous systematic studies and meta-analyses have demonstrated that, compared to traditional classroom learning and other forms of digital learning, IVR learning enhances the skills of nursing students and healthcare professionals (10, 13) and their learning satisfaction (14, 15).

Several studies argue that VR and conventional classroom learning outcomes do not differ substantially (14, 16). However, the uniqueness of previous research states that effective IVR learning enhances skills in nursing education. The urgency of this research is not much in exploring learners' competence and self-efficacy skills (17). Similarly, a systematic review of 18 studies indicates that although IVR is an effective tool to enhance clinical skills and self-efficacy in students, it is still unclear (18). The above statement shows that most studies have not adopted the appropriate learning theory concepts for verification and seldom explore how IVR affects skill and self-efficacy. Loading. Therefore, more empirical studies are needed to examine the effects of IVR on learning outcomes from various health professionals, including nursing students.

Nasogastric tube care is a fundamental skill for nurses. Correct nasogastric tube maintenance can nourish patients and prevent the development of comorbidities. In addition to learning how to insert a nasogastric tube, nursing personnel in the home care service must also instruct caregivers on performing the procedure (12). This study investigated the IVR for nasogastric tube care education and provided nursing students with video-based learning materials. In addition, the researchers explored the students' skills and self-efficacy using the IVR.

METHODS

Design and Participants

The research design uses quasi-experimental design with pre- and post-test designs. Population of this study includes the nursing undergraduate program in two universities in Central Java. The inclusion criteria are nursing students who are ≥ 20 years of age, have never acquired the nasogastric tube feeding procedure skills, and are in the second year (3rd and 4th semesters).

Based on the sample size calculation using the G*Power 3.1.9 (19) program, with a type I error rate of 0.05, a power of 0.80, and an effect size of 0.71 (20), the minimum sample size estimated to be required was 86 students. One hundred eight respondents, or 20% of the total sample, were selected to circumvent the response refusal rate. Using simple randomization with a computer-generated task and a 1:1 allocation ratio, 108 were subsequently assigned to the IVR group (54 students), and the control group (54 students) received video learning.

Intervention and Control Group

A group of researchers designed the content and learning sequences for the nasogastric tube feeding program with IVR. Computer assembly IVR applications were developed

using Unity 3D and C#. 3ds Max was used to construct and design virtual objects. Standard clinical guidelines and surgical procedures for nasogastric oral administration, including preparation, meal preparation, feeding, cleansing, and treatment assistance, create various scenarios. Using VR, students simulate real-world scenarios and complete the tasks required for each design by making the correct decisions and taking the appropriate actions.

The researchers provide direction to clarify this study's purpose, benefits, and experimental methods. All participants signed a consent form before participating in this study and were informed they could discontinue participation without repercussions. Before the experiment began, all participants received 10 minutes of instruction and 20 minutes of discussion from a professional lecturer with a background in nursing who taught the theoretical course. Moreover, participants in the IVR group learned the procedure via IVR situation learning, whereas participants in the control group viewed conventional video for 20 minutes.

For the control group, the researchers watched a 15-minute video nasogastric tube procedure. Moreover, both groups received online nasogastric tube feeding lectures.

Data Collection Procedures

The participants of the IVR group operated the VR system while standing in the room for four participants. With the help of the researchers, the participants wore VR mounted on their heads and started the VR experience once they were ready. The participants completed the procedure of feeding the tubes in their steps. Generally, this procedure can be completed in about 20 minutes. The researchers observed and protected participants throughout the experiment and explained VR operating procedures if necessary, ensuring the experiment went smoothly. Participants can stop the investigation at any time if they experience physical discomfort. Data containing questions regarding the demographic characteristics of the participants were collected at baseline, and included their age, sex, grade point average, visual impairment, and experience with VR.

Instruments

Nasogastric tube feeding skills questionnaires using standard operational procedures agreed upon by the nurses' association; the highest score of 100 and the lowest 10, the higher indicating, the better your skill.

Self-efficacy for learning and performance questionnaire consists of 8 items that have been tested for reliability a Cronbach alpha value was 0.87 (7). The participants' responses were measured using a 7-point Likert scale, ranging from 1 indicating "not at all true of me" to 7 indicating "very true of me". In this study the Cronbach alpha value was 0.74.

Ethical Considerations

This study was approved by the Institutional Review Board of Institut Ilmu Kesehatan STRADA Indonesia (IRB Number 000262/EC/KEPK/I/07/2023). All participants provided written informed consent and the confidentiality of their information was ensured. Participant agreement forms were collected after the researcher described the goals of the study and ensured data confidentiality. The suppressed encoding of the name each participant ensured anonymity.

Statistical Analysis

The analysis was conducted using version 24.0 of SPSS. Participants' demographic information and their scores on skill, and self-efficacy was described using frequencies, percentages, mean, and standard deviations. Using independent tests and Chi-square tests, the homogeneity of IVR and control groups about their demographic information and sample attributes is examined. Independent testing compared the knowledge, learning

motivation, learning satisfaction, and skill levels of IVRs and control groups. A pair-t test was administered to determine the difference between participants' pre- and post-test knowledge and skills. Analysis of variance for repeated measures (ANOVA) is utilized to compare the differences between two groups. *P* <0.05 is used to determine the significance of statistical analysis.

RESULTS

The mean age of the students was 20.91 years old, with a standard deviation of 0.12.

The majority of sex, precisely 60.19%, were male. The majority of participants, specifically 50.92% reported a lack of prior exposure to virtual reality technology. Similarly, a significant proportion of respondents, 60.19%, indicated the absence of any visual impairments. The demographic characteristics of the participants are presented in Table 1. No significant differences were found between the groups that utilized IVR and the control groups throughout the initial assessment.

Table 1. Comparisons of the sociodemographic data of the participants according to their group

Variables	Control Group n=54, n (%)	IVR Group n=54, n (%)	*P*-value
Age, mean (SD)[a]	20.79 (0.45)	21.01 (0.11)	0.876
GPA, mean (SD)[a]	3.01 (1.56)	3.03 (2.12)	0.567
Sex [b]			
Male	33 (61.11)	32 (59.26)	0.826
Female	21 (38.89)	22 (40.74)	
Experience with VR [b]			
No	30 (55.56)	25 (46.30)	0.286
Yes	24 (44.44)	29 (53.70)	
Visual impairment [b]			
Minus eyes	21 (38.89)	22 (40.74)	0.817
Normal eyes	33 (61.11)	32 (59.26)	

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

Mean pre-test scores on nasogastric tube feeding skills and self-efficacy were similar between the IVR and control groups presented in Table 2. The paired t-test results revealed that after the intervention, the nasogastric tube feeding skills scores of both groups increased significantly: the IVR group from 72.95 to 93.73 (t = 6.48, p < 0.001) and the control group from 73.01 to 80.72 (t = 3.45, p < 0.001), also the between-group difference did reach statistical significance. The self-efficacy scores of both groups increased significantly: the IVR group from 4.40 to 6.23 (t = − 5.48, p < 0.001) and the control group from 4.34 to 5.72 (t = 2.45, p < 0.01), also the between-group difference did reach statistical significance.

Table 2. Comparison of score between intervention and control group (n=108).

Variables	Control Group n=54, n (%)	IVR Group n=54, n (%)	t	P-value	Cohen's d
Skill					
Pre-test	73.01 (1.52)	72.95 (1.48)	1.48	0.169	0.266
Post-test	80.72 (1.49)	93.73 (1.04)	2.67	0.042	0.453
Self-Efficacy					
Pre-test	4.34 (0.55)	4.40 (0.54)	0.48	0.611	0.105
Post-test	5.72 (0.56)	6.23 (0.55)	1.94	0.038	0.598

DISCUSSION

This quasi-experimental study revealed that IVR intervention and video education escalated the nasogastric tube feeding skills and self-efficacy among nursing students. The finding presented in this study are consistent with previous systematic review conducted by Mao et al. (21), which analyzed 17 papers. According to their research, medical students who underwent IVR training exhibited notable improvements in both the speed of completing surgical procedures and their ratings on procedural checklists compared to those who got alternative training. However, Smith and Hamilton (2015) noted that despite having determined that the Foley catheter insertion skills of 20 nursing students who received VR training were superior to those who underwent conventional instruction, there was no statistically significant difference in student scores between the two models (16). One potential explanation for the variability in results could be attributed to variations in the target demographics and research objectives throughout the studies. Our literature study and the review by Smith and Hamilton (16) encompassed studies that aimed to enhance theoretical knowledge and develop procedural skills using teaching interventions. However, the examination conducted by Mao et al. (21) primarily focused on interventions that specifically targeted the training of surgical procedural skills. There is a potential for IVR to offer enhanced efficacy in the instruction of procedural skills due to its capacity to deliver realistic simulations, hence facilitating an immersive training experience for students. Additionally, IVR enables students to engage in repetitive repetition of the same procedures, further contributing to its potential effectiveness. Nevertheless, in the context of theoretical pedagogy, knowledge acquisition is predominantly dependent on individual memorization and comprehension (22).

It has been stated in the previous study that IVR was significantly increased the self-efficacy score among nursing students (23). Moreover, our finding aligns with a study conducted by Francis et al. (2020), which shown that the incorporation of VR in lecture-based training resulted in an enhancement of student self-efficacy (24). The findings of this study enhance the existing body of research that supports the effectiveness of virtual reality as a learning tool for enhancing student self-efficacy in completing nursing actions. Previous study in Korea revealed that the utilization of IVR in instructional materials pertaining to chest radiography has been found to effectively alleviate anxiety among children and enhance parental satisfaction with the treatment. The user did not provide any text to rewrite. Remarkably, while enhancing self-efficacy in terms of tracheostomy-related knowledge and care skills (25). Indeed, a prior investigation examined a VR program in Canada focused on child care following appendectomies. This study similarly showed a notable enhancement in the nursing students' self-efficacy due to their engagement with the

program (15). The fundamental principle underlying simulation learning is that knowledge acquisition occurs through experiential engagement. Simulation cultivates a nurse's cognitive processes by allowing them to encounter scenarios that closely resemble authentic clinical conditions. This method enables nursing students to gain theoretical and practical information while validating and incorporating their prior learning experiences. Therefore, it is not unexpected that the implementation of VR simulation has enhanced nursing students' self-efficacy in terms of performance (26). Consequently, the IVR intervention may be a suitable complement to comprehensive education-based technology for nursing students. Indeed, the IVR intervention may benefit nursing students to increase the skill and self-efficacy for learning and performance.

The limitation of the present study is that it included that given that the scope of this study was limited to nursing students only from two universities, it is essential to acknowledge that the findings may not be generalizable to other cohorts of individuals utilizing virtual reality simulation programs. Moreover, this study was limited to evaluating the alterations in students' self-efficacy and skill in nasogastric tube feeding solely about a singular session of IVR intervention. Consequently, the absence of an assessment of the lasting impact of IVR training on students' proficiency in nasogastric tube feeding has led to a restricted understanding of the educational outcomes associated with IVR. Further investigation is warranted to assess the potential impact of extended intravenous therapy training on enhancing skill and self-efficacy among nursing students.

CONCLUSION

The present study employed an IVR simulation application to train nursing students in Nasogastric tube feeding. The results of our investigation revealed notable enhancements in the students' performance self-efficacy and skill, along with a higher level of learner satisfaction compared to individuals who did not utilize the program. Our study showcased the efficacy of IVR simulations as a pedagogical tool for nursing students, enabling them to acquire problem-solving abilities inside virtual scenarios that closely resemble real-world situations. Moreover, this approach facilitates the enhancement of their skill set through practical application in a realistic environment. It is a recommendation that educational institutions implement this program to improve student's skills to have a good level of readiness when carrying out clinical practice. Apart from that, further research involving more samples and a more varied action focus can be carried out.

Acknowledgements

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