Check for updates

Journal of Computer Assisted Learning

WILEY

Journal of Computer Assisted Learning

ORIGINAL ARTICLE OPEN ACCESS

The Effect of Virtual Reality in Nasogastric Catheter Application Training for Nursing Students: A Randomized Controlled Trial

Ayşe Eminoğlu Güven[1] | Nazike Duruk[2] | İbrahim Savran[3]

[1]Gaziantep Islam Science and Technology University of Health Sciences Department of Nursing, Gaziantep, Turkey | [2]Eskişehir Osmangazi University of Health Sciences, Department of Nursing, Eskişehir, Turkey | [3]Eskişehir Osmangazi University of Faculty of Engineering and Natural Sciences Software Engineering, Eskişehir, Turkey

Correspondence: Ayşe Eminoğlu Güven (ayse.11.eminoglu@gmail.com)

Received: 14 February 2025 | **Revised:** 28 April 2026 | **Accepted:** 20 August 2026

Keywords: nasogastric catheter | nursing students | randomized controlled trial | skills training | virtual reality

ABSTRACT

Background: With advances in technology, innovative teaching methods are being used to teach nasogastric catheterization.

Aim: This study was conducted to evaluate the effects of training in nasogastric catheterization, delivered via traditional and virtual reality methods, on the knowledge, skills, self-confidence, anxiety and motivation of final-year nursing students.

Methods: This randomized controlled experimental design study was conducted with 78 fourth-year nursing students (39 in the intervention group and 39 in the control group) between March and May 2024. Written permission was obtained from the ethics committee, the institution and the students. Data were collected via the 'Personal Information Form', 'Nasogastric Catheterization Application Knowledge Test', 'Nasogastric Catheter Application Checklist', 'Self-Confidence Visual Analog Scale', 'Anxiety Visual Analog Scale' and 'Instructional Material Motivation Scale for Single-use'. All the students were trained according to the course content. After the training, the students in the intervention group used the virtual-reality application, and the students in the control group used it with the traditional method. After the application, the students' skills were evaluated and post-tests were applied. The data were evaluated using chi-square analysis, independent-samples *t*-tests and two-way analysis of variance with repeated measures.

Results: There was no significant difference in knowledge and motivation scores between the intervention and control groups ($p > 0.05$). The students in the intervention group had significantly greater nasogastric catheterization skills, critical procedure step scores and self-confidence scores and lower anxiety scores than did those in the control group ($p < 0.05$).

Conclusion: Virtual reality was more effective than traditional methods at improving students' nasogastric catheterization skills, increasing their self-confidence and reducing their anxiety. Therefore, the use of virtual reality to teach psychomotor skills, such as nasogastric catheterization, should be expanded.

Trial Registration: ClinicalTrials.gov registration number was received as NCT05815979

This article is the doctoral dissertation of the first author (PhD Thesis, Eskişehir Osmangazi University, Eskişehir, Evaluation of the Effect of Virtual Reality-Based Nasogastric Catheter Application Skill on Knowledge, Skills, Self-Confidence, Anxiety and Motivation of Graduated Nursing Students).

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.

© 2026 The Author(s). *Journal of Computer Assisted Learning* published by John Wiley & Sons Ltd.

Summary

- What is currently known about this topic?
  - Nasogastric catheter (NC) application is a complex psychomotor skill that involves cognitive, affective and behavioural learning, and incorrect placement may cause serious complications, including pulmonary aspiration, pneumothorax and death.
  - Pre-graduation acquisition of NC application competence is essential, as nurses are professionally responsible for the procedure from their first day in clinical practice.
  - Virtual reality (VR) is increasingly used in nursing education as an immersive teaching method that engages multiple senses and offers a safe environment for repeated practice.
- What does this paper add?
  - This is the first randomized controlled trial to evaluate the effects of immersive VR-based NC application training in final-year nursing students whose practical preparation was disrupted by the COVID-19 pandemic and the Kahramanmaraş earthquakes.
  - Immersive VR training significantly improved skill performance and self-confidence and reduced anxiety in the NC application compared to the traditional method.
  - The study introduces the use of a Critical Procedural Step (CPS) score within the NC Application Checklist, providing a more sensitive measure of safety-related performance for which no previous national or international evidence exists.
- Implications for practice/or policy
  - Immersive VR-based training can be safely integrated into final-year nursing curricula as a supportive method for teaching complex psychomotor skills such as NC application, especially for student cohorts whose hands-on practice has been limited.
  - Educators should pay particular attention to the safe execution of Critical Procedural Steps when teaching and assessing NC application, as accurate completion of these steps is directly linked to patient safety.
  - VR may be particularly valuable for reducing anxiety and increasing self-confidence in students preparing to perform high-risk procedures on real patients for the first time.

1 | Introduction

Since there are risks to patient safety during nasogastric catheter (NC) insertion, correct catheter placement is vital. Serious complications such as pulmonary aspiration, pneumothorax, abscess, hemothorax, bronchopleural fistula and perforation may be observed as a result of tracheobronchial intervention accidents. These complications can lead to death (Vadivelu et al. 2023; Walldorf et al. 2020). In the 2011 report of the National Patient Safety Agency (NPSA), 21 of 79 patients harmed during feeding due to misapplication of NC between 2005 and 2010 died (Alert 2011). In another report, 35 of 187 NC misplacements resulted in pneumothorax, and 5 resulted in death (Sparks et al. 2011). Therefore, correct catheter placement and early detection of misplaced catheters are important (Powers 2019).

Nasogastric catheter insertion and the oral, nasal and catheter care of patients with catheters play important roles in nursing care and are the nurse's responsibility. This situation is also included in the Nursing Regulation in Turkey. Under the regulation, the determination of patients' nutritional needs, the planning of nutrition and the application of NC for nutrition are the responsibility of nurses (Regulation 2011). The application of NC, which is vital and involves complex situations, should be taught well. In the Nursing National Core Education Program (NNCEP), the skills 'NC placement and care' and 'NC removal' are included as practices to be taught in nursing education (Nursing Education Association 2022).

With advancing technology, there has been a transition from traditional teaching methods to innovative teaching methods in NC applications (Chang and Lai 2021). Virtual reality (VR) applications, innovative approaches in nursing education, have become widespread in recent years to meet the expectations of the digital generation born and growing up in the age of technology, alongside evolving educational strategies (Liang et al. 2021; Martlı and Dincer 2021). Although basic nursing skills are taught in the classroom and through laboratory applications, students have very few opportunities to experience them in the laboratory and do not have the chance to practice on real patients. Therefore, there is a need for teaching methods that provide technological support and strengthen students' learning experience in skills such as NC. Considering the interest and predisposition of the new and young generation, called Generation Z, to technology, it is predicted that the skills to be gained with VR will attract the students' interest, reduce their fear and anxiety while practicing the skills on real patients, and increase self-confidence (Güngör et al. 2023; Sarikoc 2016). As a result, demand for innovative educational technologies in nursing education is increasing daily. More research is needed to integrate technology into nursing education and practices and to evaluate the effectiveness of innovative practices (Hampton et al. 2020; Harerimana and Mtshali 2020).

Learning a clinical skill in nursing education is not only about knowledge and the correct steps of a procedure. Self-confidence, anxiety and motivation also play an important role in how well a student performs a skill. When students feel anxious or unsure of themselves, their psychomotor performance is often affected. Motivation, on the other hand, helps students stay engaged with what they learn (Aoyama et al. 2013; Melincavage 2011; Sarikoc 2016). Therefore, evaluating these affective outcomes alongside knowledge and skill provides a more complete picture of how an educational intervention operates in clinical skill training.

In Turkey, nursing education was significantly affected by two consecutive crises that disrupted the practical preparation of a specific cohort of students. Following the declaration of the COVID-19 pandemic on March 14, 2020, face-to-face education was suspended and the Fundamentals of Nursing course

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

was delivered online. This is the course in which fundamental psychomotor skills, including NC application, are first taught. During this period, students were unable to perform laboratory practice of basic nursing skills and could not participate in hospital placements. Education subsequently resumed in hybrid and then face-to-face formats, and students returned to clinical placements. The Kahramanmaraş earthquakes of February 6, 2023, caused a further disruption to clinical practice. Although the students in this study completed their courses and clinical rotations, they had fewer opportunities to practice clinical skills than students before the pandemic. This is especially important for skills such as NC application, where repeated practice is essential. Some research has investigated VR-based NC application training in nursing education (Chiang et al. 2017; Kızıl and Şendir 2021; Lo et al. 2022; Yoon et al. 2024). However, all of these studies were conducted with first- or second-year students. There is no published study that has examined the effect of immersive VR-based NC training in final-year nursing students. Final-year nursing students are about to enter the profession. It is important that they graduate with the necessary professional competence and skills, because they will soon take responsibility for patient care in clinical practice. From this perspective, the present study was conducted as a pretest–post-test, randomized, controlled experimental trial to evaluate the effects of NC application training using VR and traditional methods on the knowledge, skills, self-confidence, anxiety, and motivation of final-year nursing students.

1.1 | Research Hypothesis

Hypothesis 1. *There is a difference between the knowledge scores of students who received NC application training* via *traditional and VR methods.*

Hypothesis 2. *There is a difference between the skill scores of students who received NC implementation training* via *traditional and VR methods.*

Hypothesis 3. *There is a difference between the self-confidence scores of students who received NC application training* via *traditional and VR methods.*

Hypothesis 4. *There is a difference between the anxiety scores of students who received NC practice training* via *traditional and VR methods.*

Hypothesis 5. *There is a difference between the motivation scores of students who received NC implementation training* via *traditional and VR methods.*

2 | Methods

2.1 | Design

This study was conducted with a randomized controlled experimental design. The determination of the intervention and control groups was reported according to the CONSORT (Consolidated Standards of Reporting Trials) flowchart (Schulz et al. 2010) (Figure 1). The Clinical Trials registration number was received as NCT05815979.

2.2 | Participants

The study population consisted of 135 fourth-year students in the nursing department of Eskişehir Osmangazi University, Turkey. The sample size was calculated using the G*Power 3.1.9.4 program. Taking into account the mean and standard deviation scores from the NC insertion skill checklist in the reference study, the calculation was performed with $\alpha = 0.05$, the power of the test (1-β) was 0.95, the effect size d = 0.8487568, and the number of tails = two. The sample size was determined to be 76 in total, with a minimum of 38 per group (Turaç et al. 2017).

- Inclusion criteria
  - To have completed all 4th-grade vocational courses with clinical practice,
  - Volunteering to participate in the study.
- Exclusion criteria
  - To graduate from high schools providing health education,
  - Working in a health-related job in any health institution.
- Removal criteria
  - Not participating in group work;
  - Not participating in the pretest and post-test evaluation stages;
  - Filling in the data collection forms of the research incompletely
  - Wanting to withdraw from the research.

It is important to increase the sample size by 10% to control for bias from sampling losses (Akın and Koçoğlu 2017). In line with the literature, it was determined that a minimum of 42 students per group and 84 students in total should be included in the study, accounting for 10% participant loss. We started with 85 students who agreed to participate in the study and met the inclusion criteria. A total of 7 of the 85 students, 3 in the intervention group and 4 in the control group, were excluded from the study because of the exclusion criteria. The study was completed with 78 students, with 39 students in each group. Post hoc power analysis (post hoc power) was performed with the G*Power 3.1.9.4 program, taking into account the mean and standard deviation scores of the students from the NC insertion skill checklist. When the confidence interval was calculated with $\alpha = 0.05$, effect size d = 1.1766968, df = 76, and Tails = Two, 39, the power of the test (1-β) was determined to be 99%.

2.2.1 | Randomization

All stages of randomization were conducted by an independent statistician who was not involved in any other aspect of the study. The 85 eligible students were stratified by sex, overall grade point average (GPA), Nasogastric Catheterization Application Knowledge Test (NCAKT) pretest score, and Nasogastric Catheter Application Checklist (NCAC) pretest score and were then randomly allocated using the RAND() function in Microsoft Excel. The intervention and control groups were

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

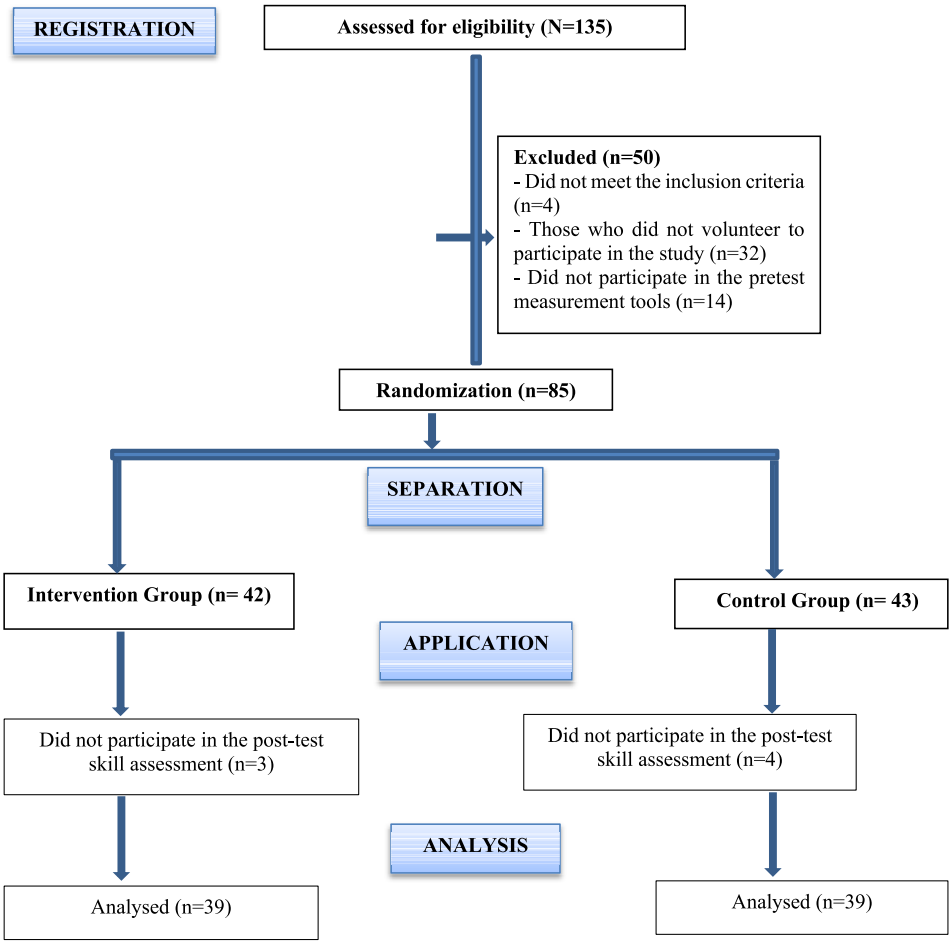


FIGURE 1 | CONSORT diagram of this study.

assigned via a blinded lottery, resulting in two groups (intervention: $n=42$; control: $n=43$).

To test group homogeneity, a chi-square test was used to examine the relationship between sex and groups, whereas independent-samples *t*-tests were used to compare GPA, knowledge and skill scores. The results revealed no significant relationship between the groups and sex ($X^2=0.04$; $p=0.828$) and no significant differences between the groups for GPA ($t=1.241$; $p=0.218$), knowledge scores ($t=0.088$; $p=0.930$), or skill scores ($t=0.771$; $p=0.443$) ($p>0.05$). As a result, the study consisted of two homogeneous groups: the intervention group ($n=42$) and the control group ($n=43$).

2.2.2 | Blinding and Bias

Blinding was reported in accordance with the CONSORT 2010 recommendations, which advise specifying who was blinded and how, rather than using ambiguous terms such as single-blind or double-blind. Due to the nature of the intervention (VR vs. traditional training), blinding of the participants and the researcher delivering the training was not possible. However, blinding was applied at the outcome assessment and data analysis stages. The two independent observers who scored the NCAC during the skill assessments were blinded to group allocation. The statistician who analysed the data was different from the statistician who conducted the randomization and was also blinded to group allocation. Before entering the data into SPSS, the researcher coded the groups as '1' and '2' to maintain statistician blinding. These measures were applied to minimize detection bias and analytical bias.

2.3 | Study Timeline and Context of the Target Population

2.3.1 | Context of the Target Population

At Eskişehir Osmangazi University, the Fundamentals of Nursing course is delivered in the spring semester of the first year. NC application knowledge and skills are first taught in this course. The students who took part in this study were enrolled in the course in the 2019–2020 spring semester. Two weeks after the course began, the COVID-19 pandemic was declared on March 14, 2020. Face-to-face education was suspended. The rest of the course was delivered online through asynchronous PowerPoint presentations and videos. During this period, students could not receive hands-on skills training in the vocational skills laboratories. They also could not participate in hospital placements. After the pandemic, no compensatory laboratory training was offered for the Fundamentals of Nursing course at Eskişehir Osmangazi University. Education then resumed in hybrid and face-to-face formats, and students

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

returned to clinical placements. NC-related theoretical content was briefly revisited in the Internal Medicine Nursing, Surgical Nursing and Paediatric Nursing courses in subsequent years. However, opportunities for repeated one-to-one practice of the NC application skill remained limited. Before the clinical placements for these courses, the clinical mentors supervising the students were informed that the cohort had not received face-to-face training in the Fundamentals of Nursing course. The mentors were therefore briefed on the basic nursing skills covered in that course, including NC application, to support the students during their clinical practice.

2.3.2 | Study Timeline

The present study was planned in 2023. Ethical approval was obtained on March 21, 2023 (Decision no. 209.23.13). The VR software was developed between 2023 and early 2024. During the same period, the training content was validated by expert panels. The measurement instruments and the VR application were also tested in pilot studies. The implementation phase of the study was carried out between March 14, 2024, and May 20, 2024. By this time, the students had reached their final year and were approaching graduation. The complete study workflow is shown in Figure 4.

2.4 | Data Collection Tools

2.4.1 | Personal Information Form

In this form, which was created by the researchers in line with the literature, there are a total of 10 questions, including students' age, sex, last graduated school, eyeglass use status, GPA, theoretical course presentation about NC application skill in the Fundamentals of Nursing course and the status of watching videos about NC during nursing education, the status of watching NC application skill from videos outside the course and experiences related to NC application skill and clinical areas where the application was performed (Karaçay 2017; Smith and Hamilton 2015).

2.4.2 | Nasogastric Catheter Application Knowledge Test

The Nasogastric Catheter Application Knowledge Test consists of 25 multiple-choice questions that assess the knowledge required for NC application skills and was prepared by researchers in line with the literature (Astle et al. 2023; Novieastari et al. 2019). Each question has five choices. Incorrect answers are evaluated as zero, and correct answers are evaluated as one point. A minimum score of 0 and a maximum score of 25 can be obtained from this test. The correct answer options for the test questions were evenly distributed. As a result of the evaluation, it is concluded that the higher the students' NCAKT scores, the more effective the lectures on the course content are for learning. Regarding the reliability of the knowledge test, the Kuder–Richardson 20 (KR-20) reliability coefficient was calculated as 0.82 in this study, indicating good internal consistency.

2.4.3 | Nasogastric Catheter Application Checklist

The Nasogastric Catheter Application Checklist was prepared by researchers in the literature (Astle et al. 2023; Berman 2021; Potter et al. 2021). The checklist includes 85 steps: 53 for the NC insertion skill and 32 for the NC removal skill. In the checklist, 2 points are given for each step performed completely, 1 point for each step observed as incomplete, and 0 points for each step not performed. For the insertion skill, a minimum score of 0 points and a maximum score of 106 points were obtained; for the subtraction skill, a minimum score of 0 points and a maximum score of 64 points were obtained and a minimum score of 0 points and a maximum score of 170 points were obtained in total. Reliability analysis demonstrated a statistically significant and excellent level of interrater agreement between the scores assigned by the first and second raters for the Nasogastric Catheter Application Skill (ICC = 0.983; $p < 0.001$), supporting the consistency of the checklist evaluations. As a result of the evaluation, it was concluded that the higher the students' NCAC scores, the higher their psychomotor performance on the NC application skill.

2.4.4 | Determination of Crucial Steps From the Nasogastric Catheter Application Checklist

Eight experts were consulted to identify the 85 items in the Nasogastric Catheter Application Checklist that were directly related to NC application skills as critical procedural steps (CPSs). The expert opinions were evaluated using the Lawshe technique. The content validity ratios for the NC insertion and removal skill CPSs were calculated as −1 and 1, respectively, and the content validity indices were calculated as 0.92 and 0.97, respectively. As a result of these procedures, 22 items for the NC insertion skill, 8 items for the NC removal skill, and 30 items in total were identified as CPSs within the NCAC. Reliability analysis demonstrated statistically significant and excellent interrater agreement between the scores given by the first and second evaluators for the Critical Steps of Nasogastric Catheter Application Skill (ICC = 0.980; $p < 0.001$), supporting the consistency of the checklist evaluations.

2.4.5 | Self-Confidence Visual Analog Scale

The visual analog scale was developed by Cline and colleagues and consists of a 10 cm-long horizontal line (Cline et al. 1992). The validity and reliability of the scale for assessing pain in Turkey were evaluated by Eti Aslan (2006). The visual analog scale (VAS) is accepted as a safe, valid and usable measurement tool for repeated measurements. In simulation-based learning research, single-item VAS instruments are particularly suitable for assessing self-confidence. They minimize respondent burden across repeated pre- and post-intervention measurements, capture the situational nature of self-confidence in performing a specific psychomotor task and have demonstrated validity in similar clinical skill-simulation contexts (Turner et al. 2008). VAS was prepared as '0: no self-confidence and 10: very high self-confidence' to determine the self-confidence level of the students. The self-confidence score was calculated by measuring the area marked by the students on the scale.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2.4.6 | Anxiety Visual Analog Scale

The visual analog scale was developed by Cline and colleagues and consists of a 10 cm-long horizontal line (Cline et al. 1992). The Turkish validity and reliability of the scale were assessed by Eti Aslan (2006). The VAS is accepted as a safe, valid, and usable measurement tool for repeated measurements. In educational research with nursing students, the VAS-A is regarded as a particularly useful tool for assessing situational (state) anxiety associated with skill practice. It enables rapid, repeated measurements with minimal cognitive load (Lavedán Santamaría et al. 2022). The VAS was prepared as '0: no anxiety and 10: very high anxiety' to determine the anxiety level of the students. The anxiety score was calculated by measuring the area marked by the students on the scale.

2.4.7 | Instructional Material Motivation Scale for Single-Use

It was developed by Barut Tugtekin and Dursun (2022). This scale is used to determine the user's motivation for a single-application material when the user relies solely on it. The scale is a 5-point Likert-type scale, with responses graded from 'Strongly Disagree' to 'Strongly Agree'. The lowest score is 1, and the highest score is 5. The lowest score on the total scale is 14, and the highest is 70. A high total or average score on the scale indicates that the individual's motivation towards the material being evaluated is high. The Instructional Material Motivation Scale for Single Use (IMMS-SU) consists of one dimension and 14 items. There are no reverse items in the scale. The Cronbach's alpha coefficient for the whole scale was reported as 0.95 (Barut Tugtekin and Dursun 2022). For this study, Cronbach's alpha was 0.91.

2.5 | Research Implementation Process

The study's implementation consisted of three stages: preparation, preapplication and application. In the first stage of the study, training content and PowerPoint presentations were prepared, knowledge tests and checklists for NC application skills were developed and scales were established. The software for the nasogastric catheter application to the VR goggles was realized and integrated into the goggles. Expert opinion was consulted for the creation of training content, measurement tools and VR application. In the second phase of the study, pilot applications were conducted to test the functionality of NCAKT, NCAC and VR applications. In the third stage, to ensure homogeneity between the intervention and control groups, students' knowledge of NC application was assessed according to NCAKT, and their NC application skills were assessed according to the NCAC by having them practice on a medium-real simulator in the professional skills laboratory of the faculty where the research was conducted (pretest). The students were randomly divided into intervention and control groups. The researcher presented a PowerPoint on the NC application skills of all the students and then demonstrated them on a medium-reality simulator. Students who were given free study time were allowed to complete the NC application using the traditional and VR methods, depending on their group. Data on students' knowledge of NC applications, skills, self-confidence, anxiety and motivation were collected. The data were evaluated using the findings from the pretest and post-test stages.

2.5.1 | The Preparation Phase of the Research

2.5.1.1 | Preparation of Training Content. The theoretical training on nasogastric catheterization was prepared by researchers in line with the literature (Astle et al. 2023; Baykara et al. 2021; Berman 2021; DeLaune et al. 2019; Fernandes et al. 2022; Lynn 2018; Novieastari et al. 2019; Potter et al. 2021). The training content included theoretical information on the NC, NC insertion and removal steps, and the rationale for applying these steps. The training was prepared for presentation in Microsoft PowerPoint. For the content validity of the presentation, the opinions of three faculty members who are experts in the field of Fundamentals of Nursing were sought. Adjustments were made in line with the feedback received from the experts. The PowerPoint presentation consisted of 33 slides. The presentation was held in a faculty classroom where the research was conducted.

2.5.1.2 | The Preparation Stage of the Knowledge Test. The face validity of the NCAKT was evaluated by two faculty members who are experts in measurement and evaluation, and the researchers created a specification table. Five experts were consulted for the content validity of the knowledge test. The feedback from the expert opinions was evaluated according to the Davis technique; the content validity ratio was 0.8 and 1, and the content validity index was 0.94 (Davis 1992).

2.5.1.3 | The Preparation Stage of the Checklist. After the 87-item NCAC was prepared in line with the literature, the comprehensibility of the process steps and expressions was evaluated by two faculty members who are experts in measurement and evaluation for face validity.

Five experts were consulted for the content validity of the skill checklist. Following expert feedback, the content validity rate and content validity index of the NCAC were evaluated using the Davis technique (Davis 1992). As a result of the evaluation, the content validity ratio and content validity index were calculated as 0.4 and 1 for the NC insertion and removal skills, respectively, and as 0.98 and 1 for the NC insertion and removal skills, respectively. Since the content validity ratio of two items related to wearing skills was less than 0.8, they were removed from the checklist, and the final version of the NCAC included 85 items.

2.5.1.4 | The Preparation Phase of the Virtual Reality Application

2.5.1.4.1 | Virtual Reality Glasses and Specifications. Two 'Oculus Quest 2' VR goggles were used in the study. Oculus Quest 2 enabled content to be prepared in 360 degrees and allowed watching videos with audio. The computer-generated videos gave users the feeling of being there. The VR goggles have special lenses, and the images are shown more clearly and larger. Oculus Quest 2 is compatible with iOS and Android and features a Qualcomm Snapdragon XR2 processor. The VR goggles that touch the face are covered with a

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

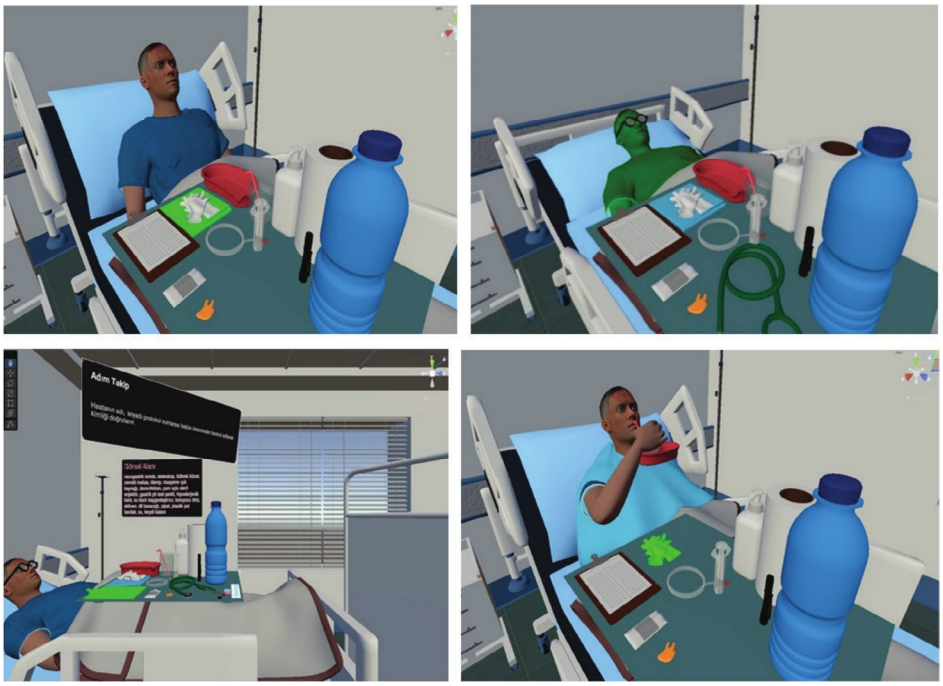


FIGURE 2 | Virtual reality application.

soft sponge and have two belts that wrap around the head. The belt around the head is adjustable. The Velcro structure that wraps from above supports full placement in the eye. These arched structures are used to ensure a perfect fit to the head and face, and allow users with glasses to wear them with their glasses. The goggles can be charged with a power unit before use, and no power unit is needed during use. The VR goggles have two joystick controllers, each powered by two batteries. The goggles can provide a wireless internet connection with Wifi. The VR goggles used in the research have storage capacities of 128 and 256 GB.

2.5.1.5 | Development Process of a Virtual Reality Application

2.5.1.5.1 | Scenario Design. The VR application was built around two modules. The first module covers NC insertion and includes 53 procedural steps. The second module covers NC removal and includes 32 procedural steps. Each step was created as a separate scene in the Unity environment. The scenario takes place in a hospital room with a patient and a nurse. The user sees the scene from the nurse's perspective. All necessary materials were placed within easy reach in the practice area. A reference screen on the opposite wall showed the names and images of the materials needed at each step. Two guidance features were added to help users follow the procedure. The first was a message box above the nurse's head that displayed the current step and followed her head movement. The second was an audio narration that played simultaneously with the on-screen text. Each audio clip lasted between 3 and 13 s. When a user completed a step, the next scene was loaded automatically (Figure 2).

2.5.1.5.2 | Software Development Process. The VR software was developed for the Oculus Quest 2 platform. This platform was chosen because it can run without external hardware, has a 90 Hz refresh rate, built-in cameras for motion tracking, a Snapdragon XR2 processor, and SDK and API support for developers. The application was built in Unity (version 2022.3.18f1) with the XR Interaction Toolkit 2.1, using C# as the programming language. Throughout the development process, the research team and the software developer worked closely together. The research team provided photographs of the materials used in the NC application, reference videos, written procedural steps and audio recordings. These materials were then integrated into the relevant scenes. The application was first tested on a computer and then on the Oculus Quest 2 headset. Issues identified during these tests were corrected through repeated test cycles, and the final software was loaded onto the VR goggles. The flow chart of the program run for both modules is shown in Figure 3.

2.5.1.5.3 | Content Validation by Experts. The VR application's applicability was evaluated by three experts. Two of them are faculty members in Fundamentals of Nursing, and one is a faculty member in Internal Medicine Nursing. The experts made three main recommendations. First, the materials needed for the NC application should be placed closer to the practice area. Second, a user manual should be prepared to explain how to use the VR goggles and controllers. Third, verbal and on-screen cues should clearly mark the start and end of the application. In line with these recommendations, the materials in the virtual environment were rearranged, the synchronization between the audio narration and the on-screen text was improved, and a user manual was prepared. The final software for both modules was then loaded onto the VR goggles.

2.5.2 | Preapplication Phase of the Research

2.5.2.1 | Piloting the Knowledge Test. To assess the comprehensibility of the questions in the Nasogastric

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

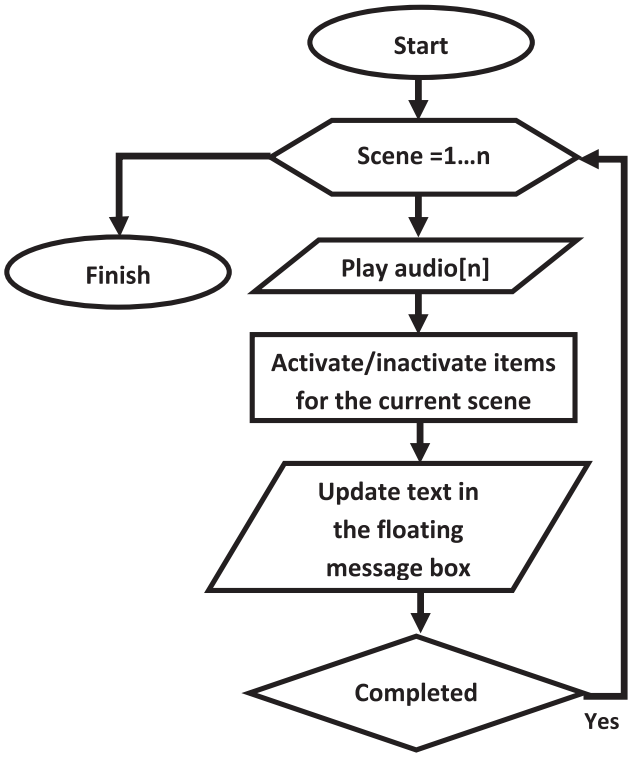


FIGURE 3 | Creation process of virtual reality software.

Catheterization Knowledge Test, a pilot study was conducted with 83 2nd-year students who had successfully completed Eskişehir Osmangazi University's Fundamentals of Nursing course. The pilot study group had characteristics similar to those of the sample group (students who took the Fundamentals of Nursing course online due to the earthquake in Turkey on February 6). According to the pilot application results, the item difficulty index for the knowledge test questions ranged from 0.19 to 0.48, with an overall average of 0.35. In the pilot study, the item discrimination index for the test items ranged from 0.31 to 0.65. Accordingly, 15 items in the test were determined to be very good, and 10 items were good discriminators (Büyüköztürk 2021; Hasançebi et al. 2020). Within the scope of the knowledge test's reliability, the Kuder–Richardson 20 reliability coefficient was calculated as 0.82. The knowledge test started with 25 items, and no questions were removed from the test as a result of the analysis. These analyses revealed that the 25-item NCAKT was a valid and reliable measurement tool.

2.5.2.2 | Pilot Implementation of the Skill Checklist. To assess the comprehensibility and functionality of the procedure steps in the Nasogastric Catheter Application Checklist, a pilot study was conducted with 24 2nd-grade students at the institution. The pilot study group comprised the students who participated in the knowledge test pilot. The students' NC application experiences on the medium reality simulator were evaluated by the researcher in accordance with the NCAC. After the pilot study, the NCAC was finalized.

2.5.2.3 | Virtual Reality Pilot. To assess the smooth operation and usability of the VR application and VR goggles used in the research process, as well as students' adaptation status, a pilot study was conducted with 12 2nd-year students who had successfully completed the Fundamentals of Nursing course at the institution where the research was conducted. The pilot study group included the students who participated in the pilot study of the knowledge test and checklist. The VR pilot application was conducted in the professional skills laboratory at the institution where the research was conducted. After the pilot application, students' opinions on the VR application's use and comprehensibility were collected. No problems were encountered in the pilot application regarding the use of VR goggles. After the pilot application, revisions were made regarding the simultaneous progression of the process steps in the audio and text box in the VR goggles, and they were made ready for use.

2.5.2.3.1 | VR Safety Monitoring and Management of Potential Side Effects. Immersive VR goggles can sometimes cause symptoms known as cybersickness. These include nausea, headache, dizziness, disorientation and eye discomfort (Caserman et al. 2021; Saredakis et al. 2020). Although current-generation goggles cause milder symptoms than older devices, the risk is still important to consider, especially in nursing education (Cossio et al. 2025).

Several measures were taken to reduce this risk in our study. First, a safe working boundary was drawn in the virtual environment. This boundary prevented collisions and falls during the application. It also helped reduce disorientation, which is a known way to lower cybersickness symptoms (Kelly et al. 2022). The Oculus Quest 2's teleportation feature was also used. This allowed students to move smoothly within a limited physical space and reduced motion-related discomfort. Second, each student was allowed up to three VR applications during the free practice period. This kept total exposure time short. Third, before the main study, a pilot study was conducted with 12 s-year nursing students. No issues related to VR goggle use were reported in this pilot.

During the main study, the students in the intervention group were monitored for signs of discomfort. They were also asked directly whether they experienced any symptoms during or after VR use. None of the 39 students in the intervention group reported any complications related to VR goggle use throughout the study (Table 1).

2.5.3 | The Implementation Phase of the Research

2.5.3.1 | Intervention Group. This group included students who experienced NC insertion and removal skills with the virtual reality method.

2.5.3.2 | Control Group. Students who practiced NC insertion and removal using the traditional method.

2.5.3.3 | Researcher. The PowerPoint training and the simulation demonstration were conducted by the same researcher. The researcher has 7 years of nursing experience. She works as a research assistant in an institution other than the institution where the study was conducted and is a PhD student in the field

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1 | Distribution of the descriptive characteristics of the groups ($n = 78$).

Variables		Groups: Intervention ($n = 39$) *n* (%)	Groups: Control ($n = 39$) *n* (%)	X^2	*p*
Sex	Female	32 (82.1)	31 (79.5)	0.000[b]	1.000
	Male	7 (17.9)	8 (20.5)		
Eyeglass use status	Yes	8 (20.5)	6 (15.4)	0.087[b]	0.768
	No	31 (79.5)	33 (84.6)		
Last graduated from school	Science High School	5 (12.8)	9 (23.1)	2.258[d]	0.361
	Anatolian High School	31 (79.5)	25 (64.1)		
	Other	3 (7.7)	5 (12.8)		
Monitoring the NC lecture presentation within the scope of the Fundamentals of nursing course	Yes	25 (64.1)	21 (53.8)	2.634[a]	0.268
	No	8 (20.5)	6 (15.4)		
	Partially	6 (15.4)	12 (30.8)		
Watching videos about NC during nursing education	Yes	26 (66.7)	23 (59)	0.511[a]	0.775
	No	7 (17.9)	9 (23.1)		
	Partially	6 (15.4)	7 (17.9)		
Watching NC videos outside of class	Yes	20 (51.3)	14 (35.9)	1.303[b]	0.254
	No	19 (48.7)	25 (64.1)		

	Mean ± SD	Median (min–max)	Mean ± SD	Median (min–max)	*t*	*p*
Age	22.26 ± 1.07	22 (21–25)	22.33 ± 1.3	22 (21–26)	−0.285	0.777
GPA	3.27 ± 0.28	3.22 (2.7–3.82)	3.14 ± 0.35	3.16 (2.4–3.94)	1.737	0.086
NCAC application period	65.00 ± 4.27	65 (55–70)	64.69 ± 5.49	67 (52–70)	0.276	0.783
Development of complications related to virtual reality goggles	Seen	0 (0)				
	Not seen	39 (100)				
Number of trials of the app during free working time	2.35 ± 0.48		2.48 ± 0.50		−1.141	0.258

Note: X^2: Chi-square test, a: Pearson chi-square test, b: Yates chi-square test, d: Fisher-Freeman-Halton exact test.
Abbreviations: Max, maximum value; Mean, average; Min, minimum value; NCAC, Nasogastric Catheter Application Checklist; SD, standard deviation; t, independent sample *t*-test.

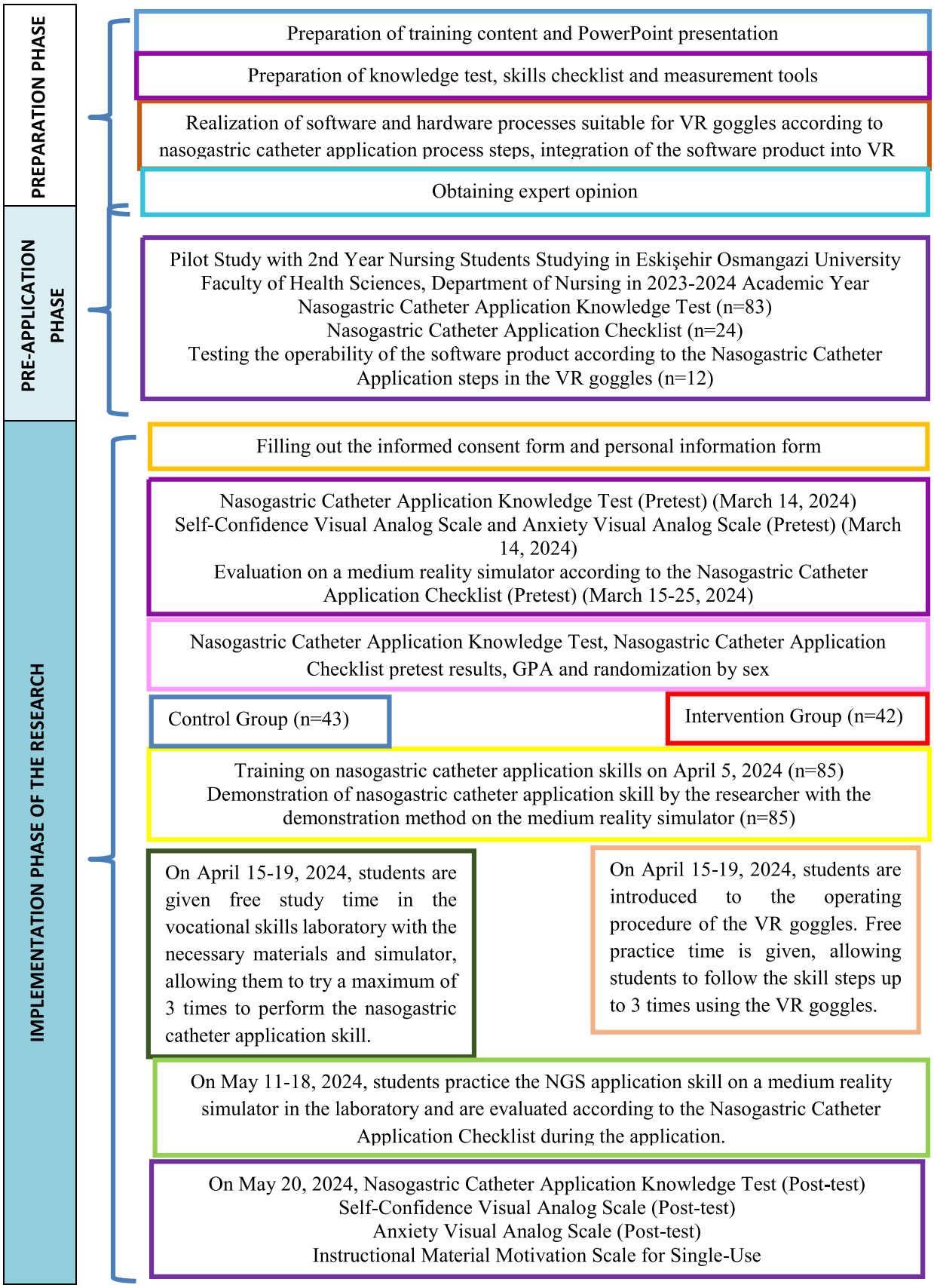
of Fundamentals of Nursing. The researcher and the students do not know each other.

2.5.3.4 | **Observer.** In this study, two observers, independent of the researcher, who were graduate students in the field of Fundamentals of Nursing, took part in evaluating the post-test NC application skill. Before the study began, the researcher informed the observers about it. The use of NCAC was explained to the observers before the application. The observers' questions were answered, and cooperation was established with them regarding the post-test assessment schedule. The observers evaluated the students according to the NCAC during the implementations carried out on the determined calendars.

2.5.3.5 | **Scholarship Holder.** Within the scope of the research project, the scholar participating in the research is a third-year nursing student. The scholar received training on NC application skills and was informed about how the application was performed and the materials used. The researcher assisted during the pretest, pilot, and post-test phases and provided support for laboratory preparations.

The implementation phase of the study was carried out between March 14, 2024, and May 20, 2024. Within the scope of the research, training was provided to all students simultaneously. Information on how the training was conducted is provided below.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License



*(Appropriate dates and times were determined for the students in the intervention and control groups).

FIGURE 4 | Research implementation flow chart.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

2.5.3.6 | NC Application Training

2.5.3.6.1 | PowerPoint Presentation. The training was delivered to all students in the intervention and control groups simultaneously. The date, time and place of the training were announced to the students 1 week in advance. The training was delivered in the classroom over one class hour (50 min) using question-and-answer, discussion and recitation methods. Necessary explanations were provided in response to the students' questions regarding the theoretical lesson.

2.5.3.6.2 | Demonstration Training. Following the PowerPoint presentation, the students were shown the steps of the NC application process via demonstration that same day. The students were divided into 5 groups of 17 students each, and the groups were taken to the professional skills laboratory to watch the application comfortably. In the laboratory, the researcher demonstrated NC insertion and removal skills on a medium-reality simulator in line with NCAC. The demonstration training, which lasted 30 min per group, was completed over three class hours (150 min).

2.5.3.7 | Steps for the Implementation of the Research

2.5.3.7.1 | Implementation in the Intervention Group.

a. First, the students were gathered in a classroom and were asked to fill out the 'Informed Voluntary Consent Form', 'Personal Information Form', 'NCAKT', 'SCVAS' and 'AVAS'.

b. After completing the abovementioned forms, the students were given appointments by the researcher on dates convenient for the students. Each student was taken to the vocational skills laboratory one by one at the allocated time and evaluated according to the NCAC on the medium-reality simulator.

c. The students were subsequently divided into groups stratified according to GPA, NCAKT, NCAC, and sex. Randomization was performed (Figure 1).

d. One week after randomization, all the students were given NC application training (PowerPoint presentation and demonstration training) by the researcher.

e. One week after the training was completed, the intervention group was introduced to the instructions for the use of the virtual reality goggles. Then, in an empty area next to the laboratory, the NC application procedure was demonstrated to the researcher in VR goggles, with safe boundaries under the researcher's supervision. The students were given free working time and allowed to perform up to three applications using the VR goggles.

f. At least 2 weeks after free practice (Büyüköztürk 2021; Özmen and Karamustafaoğlu 2019), the students performed NC insertion and subtraction on the medium-reality simulator in the laboratory, during which time they were evaluated by two observers according to the NCAC. In addition, each student's application time was recorded.

g. Immediately after the completion of the assessment, the students were asked to complete the NCAKT, SCVAS, AVAS and IMMS-SU (Figure 4).

2.5.3.7.2 | Application to the Control Group.

I. First, the students were gathered in a classroom and were asked to complete the 'Informed Consent Form', 'Personal Information Form', 'NCAKT', 'SCVAS' and 'AVAS'.

II. After completing the abovementioned forms, the students were given appointments by the researcher on dates convenient for them. Each student was taken to the vocational skills laboratory one by one at the allocated time and evaluated according to the NCAC on the medium-reality simulator.

III. The students were subsequently divided into groups stratified according to GPA, NCAKT, NCAC and sex. Randomization was performed (Figure 1).

IV. One week after randomization, all the students were given NC application training (PowerPoint presentation and demonstration training) by the researcher.

V. One week after the end of the training, the control group was introduced to the NCAC and given free study time under the supervision of the researcher in the laboratory, simultaneously with the intervention group, to perform the NC application on the medium-reality simulator at most three times.

VI. At least 2 weeks after the free study (Büyüköztürk 2021; Özmen and Karamustafaoğlu 2019), the students performed NC insertion and removal on the medium-reality simulator in the laboratory, during which time the students were evaluated by two observers according to the NCAC. In addition, each student's implementation time was recorded.

VII. Immediately after the completion of the assessment, the students were asked to complete the NCAKT, the SCVAS, the AVAS and the IMMS-SU (Figure 4).

2.6 | Data Analysis

The data were analysed using SPSS version 22.0. The suitability of the data for a normal distribution was examined using skewness and kurtosis values, coefficients of variation, detrended plots, and histograms, and it was determined that the skewness and kurtosis values ranged between ±1.5 (Tabachnick et al. 2013). The results revealed a normal distribution. To compare demographic variables by group, an independent-samples *t*-test was used because the parametric test assumptions were met. The chi-square test was used to compare groups of categorical variables. The means, standard deviations, medians and minimum-maximum scores were used to evaluate data on the NCAKT, NCAC, SCVAS, AVAS, and IMMS-SU. Two-way analysis of variance with repeated measures was used to compare repeated measures of the scales across groups. Since the variances were homogeneous, comparisons between groups were conducted using Tukey's test. For group comparisons, the ANOVA results were evaluated using $\eta 2$ (eta-squared).

Whether there was a difference between the observers' post-test evaluations was analysed using the intraclass correlation coefficient (ICC). For the ICCs, values below 0.5 indicate poor

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

agreement, between 0.5 and 0.75 indicate moderate agreement, between 0.75 and 0.9 indicate good agreement and above 0.9 indicate excellent agreement (Koo and Li 2016). A statistically significant perfect agreement was determined between the NCAC assessment scores of the first and second observers for the intervention and control groups, respectively (ICC = 0.934, $p < 0.001$; ICC = 0.990, $p < 0.001$). When interpreting the results, a $p < 0.05$ threshold was used for the statistical tests.

2.7 | Ethical Aspects of the Research

Written approval was obtained from the ethics committee of Gaziantep Islam Science and Technology University (March 21, 2023, Decision no. 209.23.13) and from the university where the study was conducted. Permission was obtained from the dean of the faculty where the research was conducted to use the professional skills laboratory. Permission was obtained from the scale owners for the scales used in the study. The purpose and method of the study were explained to the students, and their informed consent was obtained. Since individual rights should be protected in the research, the Helsinki Declaration of Human Rights was adhered to during the research process. After the study ended, the intervention group procedure was applied to students in the control group who wanted to practice with VR goggles.

3 | Results

The intervention and control groups were homogeneous with respect to sex, age, GPA, prior exposure to NC theoretical content and instructional videos, and post-test NC application duration ($p > 0.05$; Table 1). None of the 39 students in the intervention group reported any complications related to the use of the VR goggles. During the free practice period, students performed an average of 2.35 ± 0.48 applications in the intervention group and 2.48 ± 0.50 applications in the control group (Table 1). When the intervention and control groups were compared, the intervention group had significantly higher mean scores on the NCAC, CPS and SCVAS, and a significantly lower mean score on the AVAS ($p < 0.05$) (Table 2; Figures 5–9). In addition, the group × time interaction was statistically significant for these four outcomes ($p < 0.05$), and this difference was due to the intervention group. There was no statistically significant difference between the groups in terms of the mean scores of the NCAKT or the IMMS-SU ($p > 0.05$) (Table 2).

4 | Discussion

Nasogastric catheter insertion is a complex nursing skill that involves cognitive, affective and psychomotor learning in students. Therefore, it is important that nursing students, especially final-year students nearing graduation, possess sufficient knowledge and skills. Given this importance, our research findings revealed that, compared with the traditional method, the VR method increased students' skill and self-confidence scores and decreased their anxiety scores. There was no significant difference between the groups in terms of knowledge or motivation scores. With the results obtained, Hypotheses 1 and 5 were rejected, whereas Hypotheses 2, 3 and 4 were accepted. In addition, the group-time interaction was not significant for knowledge scores, whereas it was significant for skill, self-confidence and anxiety scores. The group–time interaction indicates whether there is an effect that differentiates between groups over time. The results of this study show that the intervention and control groups changed and developed together in terms of knowledge scores. This shows that the experimental intervention was effective for the skill, self-confidence and anxiety parameters, with a significant group–time interaction, and that students in the intervention group made greater progress.

In our study, knowledge and motivation scores did not differ significantly between the two groups, and the group-time interaction was also non-significant for these outcomes. Several factors may explain this pattern. For knowledge, both groups received the same theoretical training in the same classroom environment. They were therefore exposed to the same theoretical content. The students were also in their final year and had already covered NC-related content in earlier courses. This may have produced a ceiling effect, where further measurable gains were limited. A similar pattern was reported by Lo et al. (2022), in a pretest–post-test randomized controlled trial evaluating the effectiveness of VR ($n = 54$) and 2D video training ($n = 53$) in NC feeding education of nursing assistant students at two universities in Taiwan; both groups showed significant increases in knowledge scores, but no statistically significant difference was found between the groups (Lo et al. 2022). Similarly, Karkada et al. (2019), in a quasi-experimental study comparing simulation ($n = 35$) and case scenario methods ($n = 34$) in NC feeding education of undergraduate nursing students, observed no significant difference in knowledge scores between the groups (Karkada et al. 2019). For motivation, all students were given individual free-practice sessions and could repeat the procedure up to three times at their own pace. When students are given the same opportunity to learn at their own pace, motivation may become similar across groups, regardless of the teaching method. A comparable finding was reported by Jung and Park (2022), who, in a quasi-experimental study with 60 nursing students (intervention group $n = 30$; control group $n = 30$), developed a VR-based nursing education program and found that motivation scores increased in both groups in the pretest and post-test measurements, with no significant difference between groups (Jung and Park 2022).

Consistent with our findings, Kızıl and Şendir (2021), in their randomized controlled experimental study examining the effects of haptic interactive VR and computer-based simulation technologies on students' achievement and anxiety levels in teaching NC applications to first-year nursing students, reported that the group receiving training with haptic interactive VR had higher mean scores on the skills exam and self-confidence and lower anxiety scores (Kızıl and Şendir 2021). Yoon et al. (2024), in a quasi-experimental study in which they evaluated the effect of the VR simulation training they developed for second-year nursing students' enema, NC feeding, and Nelaton catheterization skills, determined that the students in the VR group showed greater competence in NC feeding skills and had higher confidence levels than did the control group (Yoon et al. 2024). In contrast, Chiang et al. (2017) reported that there was no significant difference between the NC placement skill scores of the NC-based

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | Distribution of the knowledge, skill, critical processing step, self-confidence, anxiety and motivation scores of the groups.

			Pretest		Post-test			
NCAKT	**Variables**	***n***	**Mean ± SD**		**Mean ± SD**	**F**	***p*****	**ES**
	Intervention	39	14.18 ± 3.79		20.62 ± 2.09	0.844	0.361	0.011
	Control	39	14.00 ± 3.45		19.79 ± 2.21			
	Total	78	14.09 ± 3.60		20.21 ± 2.18	Group*Time Interaction		
			F	***p****	**ES**	**F**	***p***	**ES**
			235.358	**< 0.001***	0.756	0.647	0.424	0.008
			Pretest		**Post-test**			
NCAC	**Variables**	***n***	**Mean ± SD**		**Mean ± SD**	**F**	***p*****	**ES**
	Intervention	39	38.62 ± 11.23		139.04 ± 10.69			
	Control	39	36.77 ± 10.44		117.54 ± 16.12	26.131	**< 0.001***	0.256
	Total	78	37.69 ± 10.81		128.29 ± 17.37	Group*Time Interaction		
			F	***p****	**ES**	**F**	***p***	**ES**
			3162.253	**< 0.001***	0.977	37.206	**< 0.001***	0.329
NCAC CPS			**Pretest**		**Post-test**			
	Variables	***n***	**Mean ± SD**		**Mean ± SD**	**F**	***p*****	**ES**
	Intervention	39	16.21 ± 4.98		51.85 ± 3.18	19.882	**< 0.001***	0.207
	Control	39	15.64 ± 4.64		44.99 ± 5.65			
	Total	78	15.92 ± 4.79		48.42 ± 5.72	Group*Time Interaction		
			F	***p****	**ES**	**F**	***p***	**ES**
			2400.789	**< 0.001***	0.969	22.525	**< 0.001***	0.229
			Pretest		**Post-test**			
SCVAS	**Variables**	***n***	**Mean ± SD**		**Mean ± SD**	**F**	***p*****	**ES**
	Intervention	39	1.74 ± 1.14		8.50 ± 0.80	30.814	**< 0.001***	0.288
	Control	39	2.14 ± 1.11		6.17 ± 1.00			
	Total	78	1.94 ± 1.13		7.33 ± 1.48	Group*Time Interaction		
			F	***p****	**ES**	**F**	***p***	**ES**
			1258.389	**< 0.001***	0.943	80.720	**< 0.001***	0.515
			Pretest		**Post-test**			
AVAS	**Variables**	***n***	**Mean ± SD**		**Mean ± SD**	**F**	***p*****	**ES**
	Intervention	39	8.53 ± 0.96		2.04 ± 1.10	32.405	**0.001***	0.299
	Control	39	8.13 ± 0.98		4.72 ± 1.39			
	Total	78	8.33 ± 0.98		3.38 ± 1.84	Group*Time Interaction		
			F	***p****	**ES**	**F**	***p***	**ES**
			1010.413	**< 0.001***	0.930	97.653	**< 0.001***	0.562

	Variables				
IMMS-SU	**Final Test**	***n***	**Median**	**(Min–Max)**	**Mean ± SD**
	Intervention	39	65	55–70	65.00 ± 4.27
	Control	39	67	52–70	64.69 ± 5.49

(Continues)

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2 | (Continued)

Variables						
IMMS-SU	**Final Test**	***n***	**Median**	**(Min–Max)**	**Mean ± SD**	
					t	***p***
					0.276	0.783

Note: *$p < 0.05$; p*: Within-group comparison; p**: Comparison between groups. Bold values indicate statistically significant results ($p < 0.05$).
Abbreviations: AVAS, Anxiety Visual Analog Scale; ES, effect size; F, F statistic; IMMS-SU, instructional material motivation scale for single-use; Max, maximum value; Mean, average; Min, minimum value; NCAC, Nasogastric Catheter Application Checklist; NCAC CPS, Nasogastric Catheterization Application Checklist Critical Processing Step; NCAKT, Nasogastric Catheterization Application Knowledge Test; SCVAS, Self-Confidence Visual Analog Scale; SD, standard deviation; t, independent sample t-test.

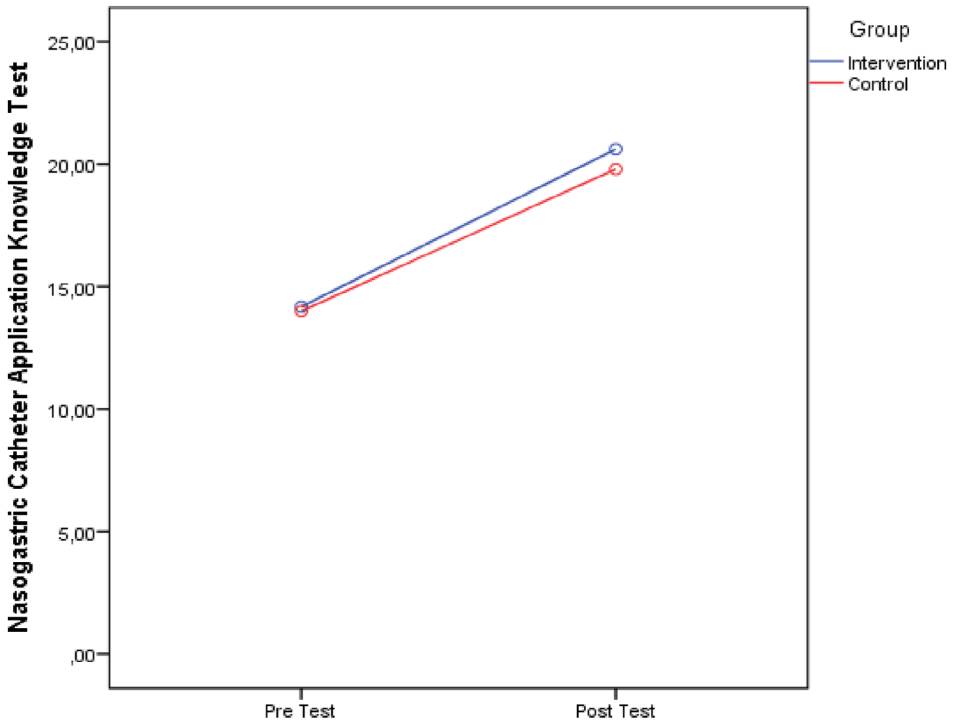


FIGURE 5 | Comparison of knowledge scores across the groups.

simulator and the control group in a quasi-experimental study in which they evaluated the effectiveness of applying a VR-based simulator with tactile feedback for second-year nursing students to learn NC placement skills (Chiang et al. 2017). The variability in skill outcomes across studies may be due to differences in student populations, years of study, prior clinical experience and measurement tools.

In learning environments where auditory, visual and action-based learning are combined, knowledge and skills become more permanent in students (Pham 2019). Virtual reality goggles also provide both visual and auditory learning environments, engaging multiple sensory organs and making the subject matter more concrete (İlic 2021). Therefore, the use of learning environments that engage multiple senses in nursing education is important for skill development. In this study, the VR method may have engaged multiple senses of students in the intervention group, such as vision and hearing, thereby making the skill easier to understand. This situation supported the development of students' skills and self-confidence and, in parallel, reduced anxiety. In addition, the differences in skill, self-confidence and anxiety scores between the intervention and control groups may be due to Generation Z, often referred to as technology natives who keep up with technological developments, being more interested in technology. Technology-supported educational methods positively affect students' perceptions of learning, effectively develop skills and self-confidence and help reduce anxiety before contact with a real patient. At the same time, students experienced a dynamic, interactive, new-generation learning method in which they took responsibility for their learning through VR, which may have been effective in improving students' skill performance and self-confidence.

Self-confidence is a vital factor in nursing practice for both students and professional nurses, as it directly influences the safe performance of clinical skills (Guerrero et al. 2022). Consistent with our findings, Baek et al. (2017), in a study with 61 nursing students, evaluating a home-based NC feeding simulation module, reported that students showed high levels of self-confidence after the simulation training (Baek et al. 2017). In contrast, Chao et al. (2021), in a study with 45 nursing students using an immersive 3D interactive video program for NC feeding skills, reported

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

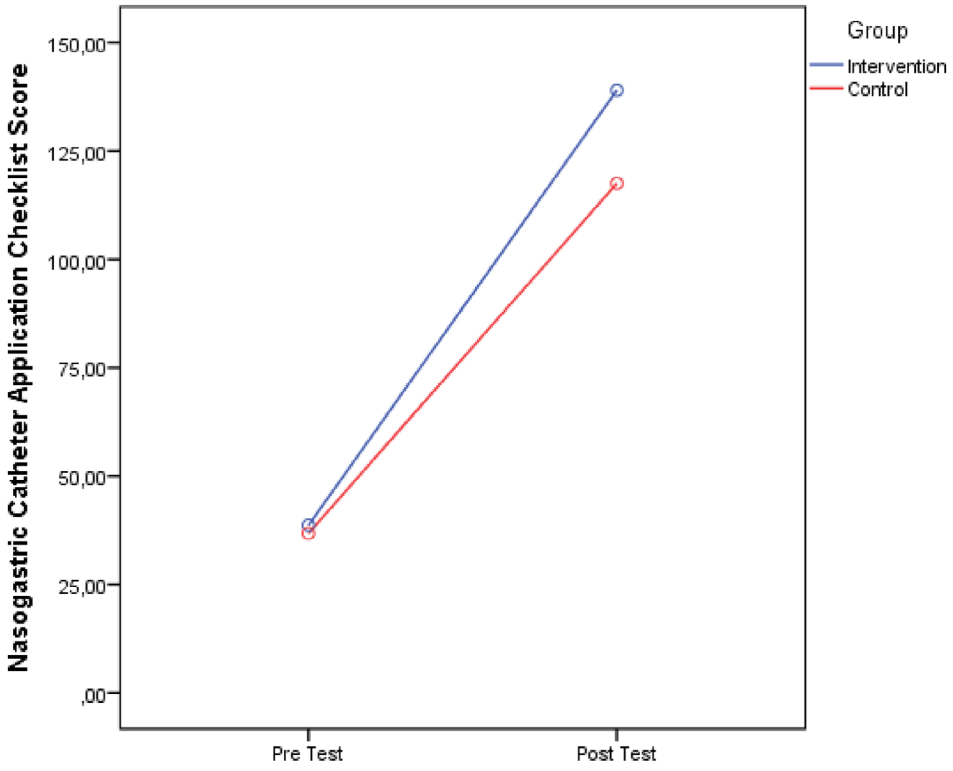


FIGURE 6 | Comparison of the skill scores of the groups.

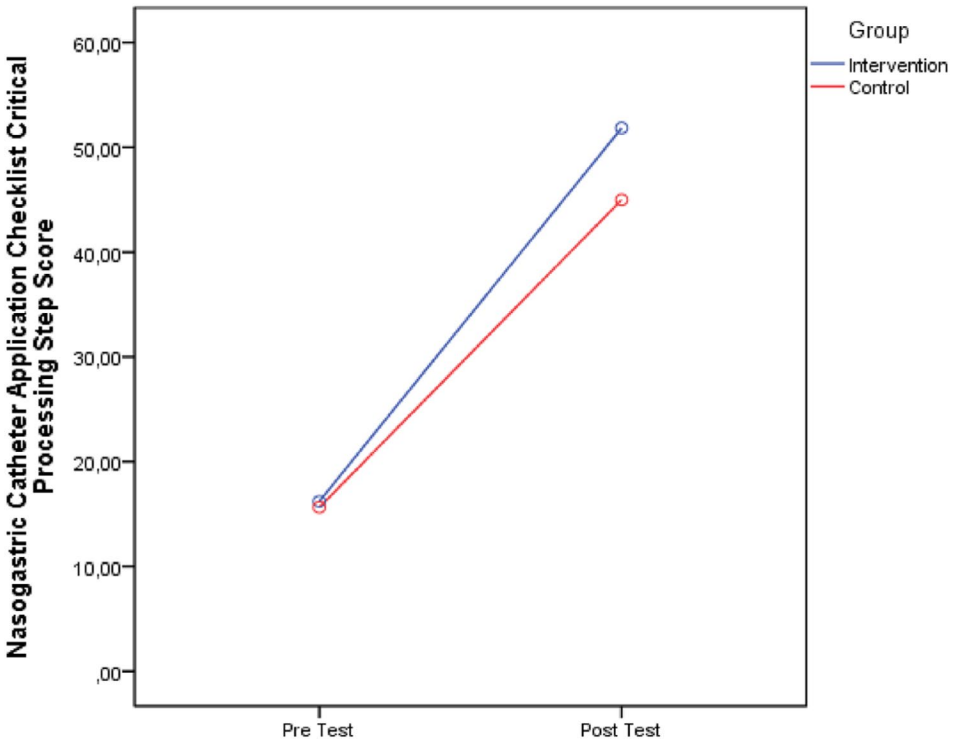


FIGURE 7 | Comparison of the critical processing step scores of the groups.

no significant difference in self-confidence scores between groups (Chao et al. 2021).

The reduction in anxiety in the intervention group is consistent with the literature. High anxiety is known to affect students' skill development and performance during practice (Midilli et al. 2017). Common sources of anxiety in nursing students include the difficulty of performing skills in the laboratory, fear of making mistakes and being observed during practice (Shearer 2016). The VR environment used in our study may have helped reduce these anxiety triggers. Students could practice the NC procedure repeatedly in a safe, controlled setting without risking harm to a real patient.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

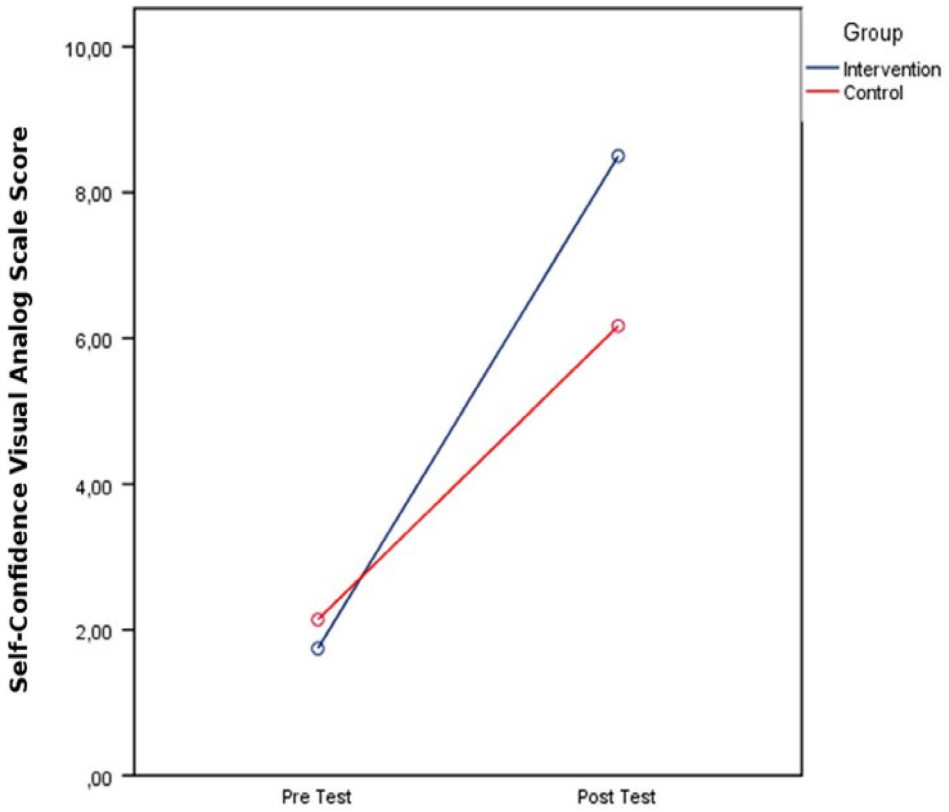


FIGURE 8 | Comparison of self-confidence scores across the groups.

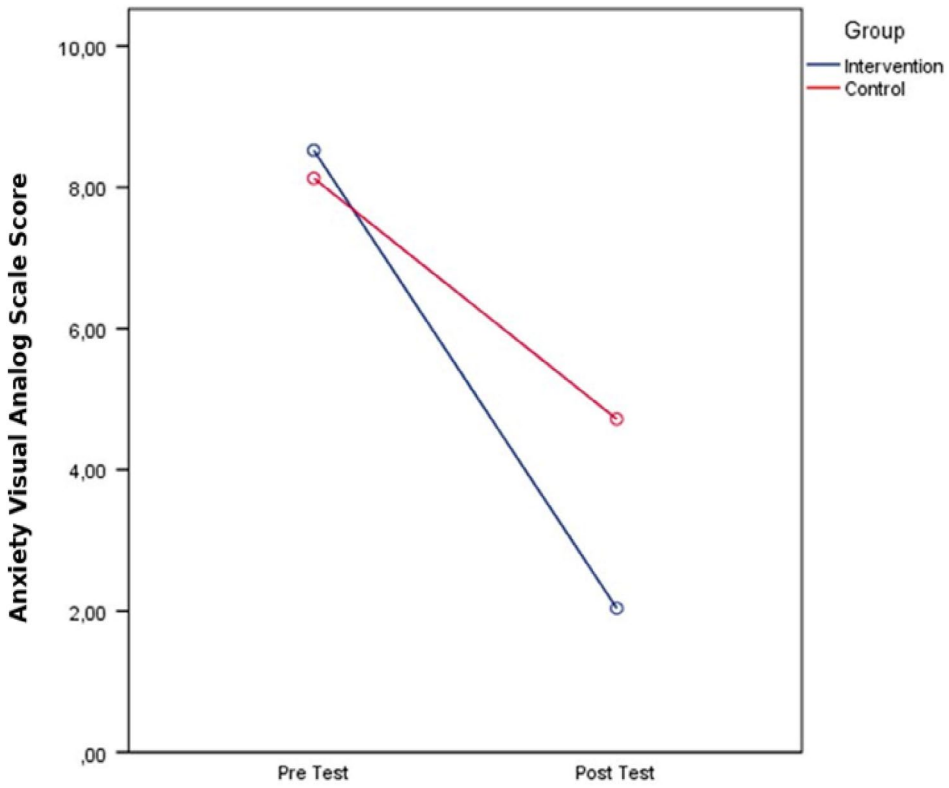


FIGURE 9 | Comparison of anxiety scores across the groups.

At the same time, they experienced the realistic feeling of being in a hospital setting. A similar finding was reported by Chang and Lai (2021) in a qualitative study with 60 nursing students learning NC application using VR goggles, who described the VR environment as a stress-free learning setting that reduced students' anxiety during skill practice (Chang and Lai 2021).

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

In this study, the CPS was determined among the NCAC. According to the findings, the mean CPS score in the intervention group was significantly higher than in the control group. In teaching nasogastric catheter application skills, the correct technique and complete execution of the CPS are important for reducing complications and ensuring patient safety. In the literature, no national or international studies evaluating the NC application CPS have been reported. In this study, measuring skills related to the NC application CPS demonstrates the study's originality. Moreover, the fact that students who used the VR method performed at a higher level, which is vital for NC application skills, suggests that it can be safely applied in education.

5 | Conclusions and Recommendations

Within the scope of the study, graduating senior nursing students experienced NC application skills with traditional and VR methods. The results of this study revealed that, compared with traditional methods, the application of NC with the VR method increased students' skills and self-confidence, decreased their anxiety and did not affect their knowledge or motivation. In line with the results obtained from the research:

- Utilizing VR-based teaching methods from innovative approaches in teaching psychomotor skills;
- Utilization of the VR method in other subjects in which basic nursing skills are gained at the Fundamentals of Nursing Education;
- Consideration of self-confidence, anxiety and motivation in teaching psychomotor skills;
- Integration of the VR method into the training program in nursing education;
- Conducting qualitative and mixed-method research on student views on NC application skills training based on VR;
- Research that reveals how the VR-based teaching method is reflected in clinical practice is recommended.

5.1 | Limitations of the Study

Several limitations to this study should be considered. The fact that students were taken individually for applications on a simulator with a medium level of realism may have been a factor that affected their anxiety levels. The fact that the students in the intervention and control groups shared the same social and academic environments may have led to information exchange between the groups. As the students who participated in the study were final-year students approaching graduation, the impact of the training on clinical practice and skill retention could not be assessed. Furthermore, differences in students' familiarity with VR technology may have influenced the application results. The presence of evaluators may have created an observer effect (Hawthorne effect) on students' performance. Finally, working with a specific group of students whose education was interrupted by the pandemic and earthquake may have affected their skills and motivation.

This study also has several methodological limitations. The study was conducted at a single nursing faculty in Turkey, which may limit the generalizability of the findings to other institutions and educational systems. The sample size was statistically adequate, but the relatively small number of participants ($n = 78$) may have affected the precision of the results. The outcome measures were assessed only in the immediate post-intervention period. Therefore, the long-term retention of knowledge and skills could not be evaluated. Future multicentre studies with larger sample sizes and longitudinal follow-up are recommended to address these limitations.

Author Contributions

Nazike Duruk: conceptualization, data curation, formal analysis, visualization, writing – original draft, methodology, investigation, supervision, project administration, writing – review and editing, validation, funding acquisition, resources. **Ayşe Eminoğlu Güven:** conceptualization, investigation, funding acquisition, writing – original draft, methodology, validation, visualization, writing – review and editing, formal analysis, project administration, data curation, supervision, resources. **İbrahim Savran:** funding acquisition, methodology, project administration, resources, software, visualization.

Acknowledgements

The authors would like to thank the faculty members who provided expert opinions, the students of the Department of Nursing who participated in the study, TÜBİTAK, Eskişehir Osmangazi University Scientific Research Projects Coordination Unit and the observers.

Funding

This research was supported by TUBITAK 1002-A Rapid Support Module as Project No. 223S099, TUBITAK 2247-C Intern Researcher Scholarship Program and ESOGU Scientific Research Projects Coordination Unit as Project No. TDK-2023-2872.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Peer Review

For transparency, the peer review documents associated with this article are available at https://doi.org/10.1002/jcal.70314.

References

Akın, B., and D. Koçoğlu. 2017. "Randomized Controlled Trials." *Journal of Hacettepe University Faculty of Nursing* 4, no. 1: 73–92.

Alert, N. P. S. 2011. *Reducing the Harm Caused by Misplaced Nasogastric Feeding Tubes*. NHS National Patient Safety Agency.

Aoyama, M., Y. Tamura, Y. Ishikawa, M. Yada, and I. Miyawaki. 2013. "Confidence-Weighted Testing: A Descriptive Study of Japanese Nursing Students." *Nursing & Health Sciences* 15, no. 4: 504–509. https://doi.org/10.1111/nhs.12066.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Duruk - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Astle, B. J., W. Duggleby, P. A. Potter, A. G. Perry, P. A. Stockert, and A. Hall. 2023. *Potter and Perry's Canadian Fundamentals of Nursing-E-Book: Potter and Perry's Canadian Fundamentals of Nursing-E-Book*. Elsevier Health Sciences.

Baek, H. C., Y. R. Lee, J. E. Lee, J. H. Lee, and H. S. Kim. 2017. "Evaluation and Application Effect of a Home Nasogastric Tube Feeding Simulation Module for Nursing Students: An Application of the NLN Jeffries Simulation Theory." *Journal of Korean Academy of Community Health Nursing* 28, no. 3: 324–333. https://doi.org/10.12799/jkachn.2017.28.3.324.

Barut Tugtekin, E., and O. O. Dursun. 2022. "Effect of Animated and Interactive Video Variations on Learners' Motivation in Distance Education." *Education and Information Technologies* 27, no. 3: 3247–3276. https://doi.org/10.1007/s10639-021-10735-5.

Baykara, G. Z., N. Çalışkan, D. Öztürk, and A. Karadağ. 2021. *Basic Nursing Skills: Checklists and Web-Accessible Training Videos*. 3rd ed. Nobel Medical Publishing.

Berman, A. 2021. *Fundamentals of Nursing: Concepts, Processes, and Practice*. 11th ed. Pearson Education.

Büyüköztürk, Ş. 2021. *Data Analysis Handbook for Social Sciences*, 1–214. Pegem Citation Index.

Caserman, P., A. Garcia-Agundez, A. Gámez Zerban, and S. Göbel. 2021. "Cybersickness in Current-Generation Virtual Reality Head-Mounted Displays: Systematic Review and Outlook." *Virtual Reality* 25, no. 4: 1153–1170. https://doi.org/10.1007/s10055-021-00513-6.

Chang, Y. M., and C. L. Lai. 2021. "Exploring the Experiences of Nursing Students in Using Immersive Virtual Reality to Learn Nursing Skills." *Nurse Education Today* 97: 104670. https://doi.org/10.1016/j.nedt.2020.104670.

Chao, Y.-C., S. H. Hu, H.-Y. Chiu, P.-H. Huang, H.-T. Tsai, and Y.-H. Chuang. 2021. "The Effects of an Immersive 3D Interactive Video Program on Improving Student Nurses' Nursing Skill Competence: A Randomized Controlled Trial Study." *Nurse Education Today* 103: 104979. https://doi.org/10.1016/j.nedt.2021.104979.

Chiang, V. C. L., T. K. S. Choi, S. S. Y. Ching, and K. L. K. Leung. 2017. "Evaluation of a Virtual Reality Based Interactive Simulator With Haptic Feedback for Learning NGT Placement." *Journal of Problem-Based Learning* 4, no. 1: 25–34. https://doi.org/10.24313/jpbl.2017.4.1.25.

Cline, M. E., J. Herman, E. R. Shaw, and R. D. Morton. 1992. "Standardization of the Visual Analogue Scale." *Nursing Research* 41, no. 6: 378–379.

Cossio, S., S. Chiappinotto, S. Dentice, et al. 2025. "Cybersickness and Discomfort From Head-Mounted Displays Delivering Fully Immersive Virtual Reality: A Systematic Review." *Nurse Education in Practice* 85: 104376. https://doi.org/10.1016/j.nepr.2025.104376.

Davis, L. L. 1992. "Instrument Review: Getting the Most From a Panel of Experts." *Applied Nursing Research* 5, no. 4: 194–197. https://doi.org/10.1016/S0897-1897(05)80008-4.

DeLaune, S. C., L. McTier, J. Tollefson, J. Lawrence, and P. K. Ladner. 2019. *Fundamentals of Nursing: Australia & NZ Edition 2e*. Cengage AU.

Eti Aslan, F. 2006. *Assessment and Measurement of Pain*, edited by F. Eti Aslan, 1st ed. Avrupa Medical Publishing.

Fernandes, A. M., P. Henriques, A. R. Lourenço, et al. 2022. "Nasogastric Tube Care and Flushing in a Portuguese General Medicine Ward: A Best Practice Implementation Project." *JBI Evidence Implementation* 20, no. S1: S76–S87. https://doi.org/10.1097/XEB.0000000000000328.

Guerrero, J. G., S. A. A. Ali, and D. M. Attallah. 2022. "The Acquired Critical Thinking Skills, Satisfaction, and Self-Confidence of Nursing Students and Staff Nurses Through High-Fidelity Simulation Experience." *Clinical Simulation in Nursing* 64: 24–30. https://doi.org/10.1016/j.ecns.2021.11.008.

Güngör, D. C., F. Orgun, and N. Özkütük. 2023. "Reflections of Changing and Developing Technologies in Nursing Education." *Journal of Health Academician* 10, no. 1: 155–161. https://doi.org/10.52880/sagakaderg.1120307.

Hampton, D., D. Welsh, and A. T. Wiggins. 2020. "Learning Preferences and Engagement Level of Generation Z Nursing Students." *Nurse Educator* 45, no. 3: 160–164. https://doi.org/10.1097/NNE.0000000000000710.

Harerimana, A., and N. G. Mtshali. 2020. "Using Exploratory and Confirmatory Factor Analysis to Understand the Role of Technology in Nursing Education." *Nurse Education Today* 92: 104490. https://doi.org/10.1016/j.nedt.2020.104490.

Hasançebi, B., Y. Terzi, and Z. Küçük. 2020. "Distractor Analysis Based on Item Difficulty Index and Item Discrimination Index." *Gümüşhane University Journal of Science and Technology* 10, no. 1: 224–240. https://doi.org/10.17714/gumusfenbil.615465.

İlic, U. 2021. "A New Course for Preservice Teachers: Instructional Technologies." *Journal of National Education* 50, no. 230: 689–704. https://doi.org/10.37669/milliegitim.679147.

Jung, A.-R., and E.-A. Park. 2022. "The Effectiveness of Learning to Use HMD-Based VR Technologies on Nursing Students: Chemoport Insertion Surgery." *International Journal of Environmental Research and Public Health* 19, no. 8: 4823. https://doi.org/10.3390/ijerph19084823.

Karaçay, P. 2017. *Evaluation of Simulation Education in Nursing in Terms of Instructor and Student Variables*. Istanbul University.

Karkada, S., J. Radhakrishnan, J. Natarajan, G. A. Matua, and M. Kaddoura. 2019. "Knowledge and Competency of Novice Nursing Students in Nasogastric Tube Feeding: Is Simulation Better Than Case Scenario?" *Oman Medical Journal* 34, no. 6: 528–533. https://doi.org/10.5001/omj.2019.96.

Kelly, J. W., T. A. Doty, L. A. Cherep, and S. B. Gilbert. 2022. "Boundaries Reduce Disorientation in Virtual Reality." *Frontiers in Virtual Reality* 3: 882526. https://doi.org/10.3389/frvir.2022.882526.

Kızıl, H., and M. Şendir. 2021. *The Effect of Haptic Interactive Virtual Reality and Computer-Based Simulation Technologies on Students' Achievement and Anxiety Levels in Nasogastric Tube Application Teaching*. Health Sciences University.

Koo, T. K., and M. Y. Li. 2016. "A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research." *Journal of Chiropractic Medicine* 15, no. 2: 155–163. https://doi.org/10.1016/j.jcm.2016.02.012.

Lavedán Santamaría, A., O. Masot, O. Canet Velez, T. Botigué, T. Cemeli Sánchez, and J. Roca. 2022. "Diagnostic Concordance Between the Visual Analogue Anxiety Scale (VAS-A) and the State-Trait Anxiety Inventory (STAI) in Nursing Students During the COVID-19 Pandemic." *International Journal of Environmental Research and Public Health* 19, no. 12: 7053. https://doi.org/10.3390/ijerph19127053.

Liang, C.-J., C. Start, H. Boley, V. R. Kamat, C. C. Menassa, and M. Aebersold. 2021. "Enhancing Stroke Assessment Simulation Experience in Clinical Training Using Augmented Reality." *Virtual Reality* 25: 575–584. https://doi.org/10.1007/s10055-020-00475-1.

Lo, Y.-T., C.-C. Yang, T.-F. Yeh, H.-Y. Tu, and Y.-C. Chang. 2022. "Effectiveness of Immersive Virtual Reality Training in Nasogastric Tube Feeding Education: A Randomized Controlled Trial." *Nurse Education Today* 119: 105601. https://doi.org/10.1016/j.nedt.2022.105601.

Lynn, P. 2018. *Taylor's Clinical Nursing Skills: A Nursing Process Approach*. Lippincott Williams & Wilkins.

Martlı, E. P., and N. U. Dincer. 2021. "Technology in Nursing Education: Augmented Reality." *Pamukkale University Journal of Engineering Sciences* 27, no. 5: 627–637.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Melincavage, S. M. 2011. "Student Nurses' Experiences of Anxiety in the Clinical Setting." *Nurse Education Today* 31, no. 8: 785–789. https://doi.org/10.1016/j.nedt.2011.05.007.

Midilli, T. S., K. Çevik, and E. Baysal. 2017. "Assessment of the Relationship Between Test Anxiety and the Levels of Knowledge and Skills About Laboratory Practices for Nursing Students." *Suleyman Demirel University Journal of Health Sciences* 8, no. 1: 43–54. https://doi.org/10.22312/sdusbed.306412.

Novieastari, E., K. Ibrahim, S. Ramdaniati, and D. Deswani. 2019. *Fundamentals of Nursing Vol 1-9th Indonesian Edition*. Elsevier (Singapore) Pte Limited.

Nursing Education Association, N. 2022. *Nursing National Core Education Program (NNCEP)-2022*. https://www.hemed.org.tr/wp-content/uploads/2023/10/hemsirelik_cekirdek_egitim_programi.pdf.

Özmen, H., and O. Karamustafaoğlu. 2019. *Research Methods in Education*. 1 st ed. Pegem Akademi Publishing.

Pham, D. C. 2019. Improving Simulation-Based Training to Better Serve the Maritime Community: A Comparative Research Between the Aviation and Maritime Domains.

Potter, P. A., A. G. Perry, P. A. Stockert, and A. Hall. 2021. *Fundamentals of Nursing-E-Book*. 11th ed. Elsevier Health Sciences.

Powers, J. 2019. "Securing Orogastric and Nasogastric Tubes in Intubated Patients." *Critical Care Nurse* 39, no. 4: 61–63. https://doi.org/10.4037/ccn2019542.

Regulation, N. 2011. Regulation on the Amendment of the Nursing Regulation. https://www.resmigazete.gov.tr/eskiler/2011/04/20110419-5.htm.

Saredakis, D., A. Szpak, B. Birckhead, H. A. Keage, A. Rizzo, and T. Loetscher. 2020. "Factors Associated With Virtual Reality Sickness in Head-Mounted Displays: A Systematic Review and Meta-Analysis." *Frontiers in Human Neuroscience* 14: 96. https://doi.org/10.3389/fnhum.2020.00096.

Sarikoc, G. 2016. "Use of Virtual Reality in the Education of Health Care Workers." *Journal of Education and Research in Nursing* 13, no. 1: 243–248. https://doi.org/10.5222/HEAD.2016.243.

Schulz, K. F., D. G. Altman, and D. Moher. 2010. "CONSORT 2010 Statement: Updated Guidelines for Reporting Parallel Group Randomised Trials." *Journal of Pharmacology and Pharmacotherapeutics* 1, no. 2: 100–107.

Shearer, J. N. 2016. "Anxiety, Nursing Students, and Simulation: State of the Science." *Journal of Nursing Education* 55, no. 10: 551–554. https://doi.org/10.3928/01484834-20160914-02.

Smith, P. C., and B. K. Hamilton. 2015. "The Effects of Virtual Reality Simulation as a Teaching Strategy for Skills Preparation in Nursing Students." *Clinical Simulation in Nursing* 11, no. 1: 52–58. https://doi.org/10.1016/j.ecns.2014.10.001.

Sparks, D. A., D. M. Chase, L. M. Coughlin, and E. Perry. 2011. "Pulmonary Complications of 9931 Narrow-Bore Nasoenteric Tubes During Blind Placement: A Critical Review." *Journal of Parenteral and Enteral Nutrition* 35, no. 5: 625–629. https://doi.org/10.1177/0148607111413898.

Tabachnick, B. G., L. S. Fidell, and J. B. Ullman. 2013. *Using Multivariate Statistics*. Vol. 6. Pearson.

Turaç, N., N. Çalışkan, and E. Gülnar. 2017. "Comparison of Mastery Learning Model and WhatsApp Assisted Learning in Teaching Psychomotor Skills: A Triangulation Study." *Journal of Human Sciences* 14, no. 3: 2601–2615. https://doi.org/10.14687/jhs.v14i3.4769.

Turner, N. M., A. J. van de Leemput, J. M. T. Draaisma, P. Oosterveld, and O. T. J. ten Cate. 2008. "Validity of the Visual Analogue Scale as an Instrument to Measure Self-Efficacy in Resuscitation Skills." *Medical Education* 42, no. 5: 503–511. https://doi.org/10.1111/j.1365-2923.2007.02950.x.

Vadivelu, N., G. Kodumudi, L. R. Leffert, et al. 2023. "Evolving Therapeutic Roles of Nasogastric Tubes: Current Concepts in Clinical Practice." *Advances in Therapy* 40, no. 3: 828–843. https://doi.org/10.1007/s12325-022-02406-9.

Walldorf, J., P. Michl, and S. Krug. 2020. "The Nasogastric Tube Is Stuck and Causes Coughing and Dyspnoea: A Rare Complication." *Intensive & Critical Care Nursing* 57: 102786. https://doi.org/10.1016/j.iccn.2019.102786.

Yoon, H., E. Lee, C.-J. Kim, and Y. Shin. 2024. "Virtual Reality Simulation-Based Clinical Procedure Skills Training for Nursing College Students: A Quasi-Experimental Study." *Healthcare* 12: 1109. https://doi.org/10.3390/healthcare12111109.

13652729, 2026, 5, Downloaded from https://onlinelibrary.wiley.com/doi/10.1002/jcal.70314 by Nazike Durak - ESKISEHIR OSMANGAZI UNIVERSITY KUTUPHANE VE DOK DAI BASK , Wiley Online Library on [04/10/2026]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License