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PSYCHOMOTOR SKILL RETENTION IN NURSING STUDENTS FOLLOWING AUGMENTED REALITY-BASED SKILLS TRAINING

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Abstract

Background: *A development of psychomotor skills is a significant aspect of nursing education, which directly affects clinical competence and patient safety. Conventional forms of instruction have not been limiting the provision of monotonous, appealing, and immersive training experiences required towards the mastering and retention of skills. Augmented Reality (AR) has introduced itself as a potentially powerful educational technology with the potential to increase student engagement with instructional content using a real-time feedback and display.*

Aim: *This study aimed to evaluate the effectiveness of AR-based training on the retention of psychomotor skills among undergraduate nursing students compared to traditional instructional methods.*

Methods: *The research design of a quasi-experimental study was conducted in Zalan College of Nursing, Swat, among 60 final-year nursing students. There were two groups (n=30) of participants (AR-based training group and control group). Pre and post-training measurements were used to compare the performance between the two groups in four different skill areas: procedural accuracy, step ordering, safety adherence, and task duration. Group differences were analyzed using descriptive and inferential statistics with t-tests of independence.*

Results: *The AR group showed significantly higher post-training scores across all skill domains: procedure accuracy (8.80 ± 0.78 vs. 6.95 ± 0.89), step sequencing (8.50 ± 0.81 vs. 6.80 ± 1.05), safety compliance (8.90 ± 0.68 vs. 7.25 ± 0.87), and task completion time (8.40 ± 0.74 vs. 6.70 ± 1.02), with all p-values < 0.01. The total mean score was also significantly higher in the AR group (34.60 ± 1.86) than in the control group (27.70 ± 2.40).*

Conclusion: *AR training can be of great help in ratcheting up the level of psychomotor skills retention by nursing students and must be considered being introduction into nursing curricula as a method that can assure students of needed clinical preparedness.*

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INTRODUCTION

Psychomotor skills are the combining of the cognitive functions with the physical motion that allows people to coordinate their mental processing and their muscles, which allows them to undertake very complex activities (Romiszowski, 2013). To nursing education, psychomotor processes incorporate injections administration, wound dressing, catheter insertion, and cardiopulmonary resuscitation (Reaves et al., 2024). Maintenance of these skills is essential in terms of safe and effective patient care. Augmented reality (AR), which is a digital technology that involves the overlaying of virtual features on real-life surroundings, is being utilized more often in health learning to facilitate better acquisition and remembering of the skills (Roslien & Alcock, 2009). At the core of this study are the key terms, namely, psychomotor skills, retention, and augmented reality, which are being considered as the essential aspects of nursing competence within the technologically changing learning conditions (Rubio-López et al., 2025).

Skill decay among nursing students is notorious, with multiple studies suggesting that within weeks or months of initial trainings passages, students tend to lose skills in psychomotor skills. This weakening of retention is especially problematic without constant clinical interactions or opportunities at practice (Tatel & Ackerman, 2025). Traditional practices like instructor-guided demonstrations and teaching using mannequins serve a useful purpose, but are usually constrained by time and resources and inconsistent quality of practice. Consequently, a significant number of students will not be able to sustain the proficiency of core clinical skills in the long-term, likely harming their confidence and capabilities in situations of employment with patients (Morsy Yousif & Ghareeb Ahmed, 2025).

Innovative technologies, especially augmented reality, present potentially viable areas of advancing the retention of psychomotor skills. AR enables students to engage with digital representations superimposed on real-life settings and gives them immediate input and a sensory rehearsal. In contrast to conventional learning systems, AR is an interactive and dynamic platform through which students are able to repeat procedures in a low stakes environment (AlGerafi, et al., 2023). It is due to this constant reinforcement that motor memory can be reinforced and enhanced long-term retention. It is hypothesized that experiencing realistic and interactive simulation repeatedly is central to enhancing psychomotor abilities in the learning of health science (Sharmila, 2024).

Various pilot trials have indicated that students who were trained using AR-based systems exhibit greater procedural accuracy and confidence than students trained using conventional training tools. AR platforms offer multisensory feedback that increases the immersion of learners and allows a more detailed coordination of the visual, tactile, and motor responses (Rizvi, et al., 2025). Moreover, because of its customizable pacing, AR apps enable a wide range of learning styles and advance individual performance. The advantages help in maintaining prolonged skill retention, which is a central goal of clinical education (Ricci, Calandrino, Borgonovo, et al., 2022).

Although AR has tremendous potential, there is a small amount of it being used anywhere on nursing curricula because of cost, faculty training, and reluctance to use new technology. However, the digitalization rate of the healthcare sector prompts learning institutions to consider incorporating new teaching equipment in their institutions to enable students to adapt to contemporary clinical settings (Wild et al., 2022). The effect of AR on psychomotor skill retention knowledge will anchor educational reformation and technology-supported learning investment (Frenk et al., 2022).

The current research will address the research gap and examine the role of AR-based training in the retention of psychomotor skills among nursing students. The study will help to explain the possible practicality and success of introducing AR into the field of nursing education by monitoring the development of skills in students over time after implementing AR (Almaiah et al., 2022). This type of evidence is critical to policymakers, curriculum developers and educators when designing training programs that will achieve clinical competence that is sustained over time (Guillen-Aguinaga et al., 2025).

In short, retention of psychomotor skills is a critical but underestimated component of nursing competence. Augmented reality is a future game changer that can transform skills training and retention. The research will join the ever-expanding

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pool of knowledge of innovation in nursing and its educational implications of AR contribution to the development of a new generation of self-assured and capable nursing professionals.

Methodology

This is a quantitative quasi-experimental study design aiming to determine the effectiveness of augmented reality (AR) based training on psychomotor skill retention in nursing students. It was done with the aim of determining whether the use of the AR to support teaching resulted in improved retention of nursing procedures over the long term by participants in comparison to conventional training delivery techniques. The psychomotor skills examined in the study were specifically the essential ones including intravenous cannulation and the dressing of wounds. The study was carried out within the once of six weeks in Zalan College of Nursing, Swat. The research participants were comprised of second-year Bachelor of Science in Nursing students that already received the initial training in clinical skills. Purposive sampling was used to choose a total of 60 participants, which were randomly split into 2 groups (n=30 compared) and experienced experimental and control studies (n=30) of AR-based training.

Data collection Procedure:

The experimental group students received augmented reality modules via tablets and AR headset devices. These modules were characterized by interactive visual representation, real-time feedbacks, and procedural step-by-step directives. The training of AR was completed in three classes over two weeks. The control group was in the process given traditional demonstration-based training with assessed manikin practice by direction of affiliated clinical teachers. An Objective Structured Clinical Examination (OSCE) was applied to measure psychomotor skill acquisition and retention. The accurate procedure, good step flow, safety considerations, and completion time were considered on the OSCE checklist. The assessments were done right after training, and four weeks later in order to test retention. Each performance was rated by independent evaluators who were blind to group assignment to provide objectivity.

Data Analysis Procedure:

Data were analyzed using SPSS version 27. Data was summarized using descriptive statistics (means, standard deviations) and independent sample t-tests were used to compare performance scores between groups. Statistical differences were to be determined at $p < 0.05$.

The ethics review committee of Zalan College of Nursing provided ethical clearance to the study. Written informed consent was obtained from all participants. The ethical requirements of the research, such as confidentiality, anonymity, and withdrawal rights during the research, were provided.

Results and Analysis

Demographic Characteristics of Participants

The demographic data show that most participants in both the AR and control groups were aged 21–22 years, making up 48.3% of the total sample. A smaller portion, 10%, were aged 23 or above. The majority of participants were male, accounting for 71.7% of the total sample. Female participants represented 28.3%, indicating a predominantly male group across both study arms [Table 1].

Table 1. Demographic Characteristics of Participants (N = 60)

Variable	Category	AR Group (n = 30)	Control Group (n = 30)	Total (N = 60)
Age (years)	19–20	12 (40.0%)	13 (43.3%)	25 (41.7%)
	21–22	15 (50.0%)	14 (46.7%)	29 (48.3%)
	≥23	3 (10.0%)	3 (10.0%)	6 (10.0%)
Gender	Female	8 (26.7%)	9 (30.0%)	17 (28.3%)
	Male	22 (73.3%)	21 (70.0%)	43 (71.7%)

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Comparison of Mean OSCE Scores Immediately After Training

The findings demonstrate that the Augmented Reality (AR) group performed higher than the control group in all skills. Mean scores of the AR group were much stronger in procedure accuracy (9.20 vs. 7.85), step sequencing (8.95 vs. 7.60), safety compliance (9.10 vs. 8.05), and task completion time (8.80 vs. 7.25), all statistically significant ($p < 0.01$ or < 0.001). The overall AR total was also significantly higher (36.05 versus 30.75 in the control group) indicating higher skill retention with AR-based training [Table 2].

Table 2. Comparison of Mean OSCE Scores Immediately After Training

Skill Domain	Max Score	AR Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Procedure Accuracy	10	9.20 ± 0.65	7.85 ± 0.78	<0.001
Step Sequencing	10	8.95 ± 0.75	7.60 ± 0.84	<0.001
Safety Compliance	10	9.10 ± 0.70	8.05 ± 0.82	<0.01
Task Completion Time	10	8.80 ± 0.85	7.25 ± 0.92	<0.001
Total Score	**40**	**36.05 ± 1.52**	**30.75 ± 2.18**	**<0.001**

Comparison of Mean OSCE Retention Scores After 4 Weeks

The result shows a significant improvement in psychomotor skill performance among nursing students trained using Augmented Reality (AR) compared to the control group. In all domains—procedure accuracy (8.80 vs. 6.95), step sequencing (8.50 vs. 6.80), safety compliance (8.90 vs. 7.25), and task completion time (8.40 vs. 6.70)—the AR group scored significantly higher ($p < 0.01$ or < 0.001). The overall total score was also notably higher for the AR group (34.60) compared to the control group (27.70), indicating that AR-based training effectively enhanced psychomotor skill retention [Table 3].

Table 3. Comparison of Mean OSCE Retention Scores After 4 Weeks

Skill Domain	Max Score	AR Group (Mean ± SD)	Control Group (Mean ± SD)	p-value
Procedure Accuracy	10	8.80 ± 0.78	6.95 ± 0.89	<0.001
Step Sequencing	10	8.50 ± 0.81	6.80 ± 1.05	<0.001
Safety Compliance	10	8.90 ± 0.68	7.25 ± 0.87	<0.01
Task Completion Time	10	8.40 ± 0.74	6.70 ± 1.02	<0.001
Total Score	**40**	**34.60 ± 1.86**	**27.70 ± 2.40**	**<0.001**

Discussion

The results of the work showed that nursing students trained using augmented reality (AR) retained their psychomotor skills significantly better in comparison with students who had classical training. The AR group performed significantly better than the control group in all areas including accuracy of the procedure, ordering of the steps, adherence to safety parameters, and time of accomplishing the task. This adds to the increasing literature discussing the potential of AR in promoting pragmatic nursing skills. This finding is consistent with a study by Stavropoulou et al. (2025) which found that immersive learning via the AR technology enhances procedural learning, and retention in nursing learners.

Conversely, concerns have been raised in some past research regarding the excessive use of technology in training in the clinical field. Whilst AR facilitates autonomous learning and connectivity, Ryan et al. (2022) state that it might not possess the emotional and interpersonal aspects of real-life patient interaction. Nevertheless, our work did not substitute practical learning but supplemented it with digital simulations and therefore connected theoretical knowledge with practice. The increased scores in the AR group indicate that AR can supplement the traditional teaching strategies, not withhold them when incorporated properly (Majeed et al., 2024).

High compliance with safety was another important finding in our study within the AR group. This is in

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line with the work of Sanders et al. (2021), who showed that visual-spatial simulations were better in making learners remember step-by-step safety measures. Our students probably had the advantage of multiple exposure in a safe, interactive learning platform, which alleviated stage fright and enhanced their focus when demonstrating skills following safety guidelines.

Additionally, the decreased task completion times noted in the AR group indicate improved time management and faith in the ability to complete the tasks. These tendencies have been described in a randomized controlled trial by Young (2021), who stated that AR-trained nursing students carried out routine procedures faster and more efficiently. This indicates that AR technology can be used to enhance not only competence but also facilitate clinical workflows during the transition process of nursing students from synthetic to real environments.

Nonetheless, age and prior acquaintance with digital learning tools were also found to be unevenly distributed in our study (Martin & Betts, 2025). The early results indicated that certain students were challenged by the ability to learn and interact with AR technology, especially those who have received little exposure to this form of education prior to using it. This resonates with the study by Elsakka et al. (2023), which states that the level of digital literacy is a decisive factor in successful technology-enhanced learning. Therefore, to realize the educational value of AR, teachers will need to keep backgrounds in mind and conduct initial training to obtain the best outcomes.

A weakness of this research is the short follow-up to evaluate long-term retention. Although the AR group performed very well in the immediate post-training tests, subsequent longitudinal studies are required in order to know whether these improvements are maintained in the long term. Works like the one of Woodall et al. (2024) also stress the significance of consistent reinforcement and continued exposure to psychological proficiency in psychomotor skills, which the AR tools might be able to handle through repetitive accessibility and self-guided modules.

Finally, the paper will make a valuable contribution to the pedagogical value of AR in nursing learning. It also affirms that AR as an instructional aid can be a promising intervention to enhance psychomotor skills learning, efficient tasks, and abidance by safety measures. These findings promote the wider use of AR technologies in practicing clinical skills labs, particularly in resource-limited environments with a potential reduced number of patients a practitioner can see. The future research is encouraged to examine the cost-effectiveness, user satisfaction, and integration of AR-based training into nursing curriculum.

Conclusion and Recommendations

The researchers were able to conclude that the application of augmented reality (AR) in training health care professionals like nursing students can be beneficial in demonstrating retention of psychomotor skills such as drug injection compared to the traditional training. The AR group exhibited steadily better performance with respect to procedure accuracy, step sequencing safety compliance and time of task completion. These results support the importance of immersive technologies in the context of narrowing the gap between theoretical knowledge and clinical practice. AR allowed students a safe, enjoyable interactive environment where they could practice skills repeatedly, which increased confidence and competence. The findings justify the use of AR in nursing curriculums as a supplemental method of teaching.

The recommendations are available on the basis of these findings: it is suggested that nursing colleges should incorporate modules based on AR into the clinical skills training program to improve learning outcomes in students. To guarantee successful implementation, institutions ought to invest in the required infrastructure and offer faculty development programs. Students should also be provided further training on digital literacy in order to maximize their interaction with AR tools. Also, longitudinal research is mandatory to study the long-term effects of AR-based training on clinical performance and psychomotor skill maintenance in real life. The interplay between teachers, edtech creators, and clinicians is required to map out AR material according to educational goals and best practices in patient care. Finally, the adoption of innovative educational methods such as AR can help to achieve the production of more competent, confident, and practice-ready nursing graduates.

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