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The Effect of Mechanical Ventilator Educational Program Via Immersive Virtual Reality Strategy on Knowledge and Skills among Nursing Students in Palestine

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This thesis was submitted in partial fulfillment of the requirements for the Master`s degree in the Intensive Care Nursing
July / 2024

Thesis Approval

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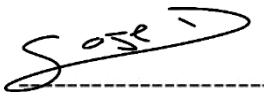
1. Dr. Sajed Ghawadra: Supervisor	
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Declaration

I dedicate this work to the Almighty Allah for preserving my life‖, to my loving parents and family (my wife and sons) who have always been a source of motivation and inspiration for me. To all who support me in my life who give me the power, love, confidence to go on …

Finally, I dedicate this work to myself to achieve my dreams.

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Acknowledgments

We would like to express here, our warm thanks to my supervisor Dr. Sajed Ghawadra, for the observation, guidance, and insightful comments throughout the implementation of this study.

A lot of thanks to Arab American University and Faculty of Health Profession and grateful appreciation to my Co-supervisor Dr. Ahmad Ewais.

We also sincerely thank all teachers, professors of college of nursing at Arab American university members, those who kindly gave us advice and assistance.

For the success of this project, I needed a helping hand from any person or group, so I will thank almighty GOD who inspired me with patience and great credit to everyone who contributed and stood by me for the success of this project, through their assurance of our faithful friendship, love, and sincere appreciation.

Mohammad Daoud Abu Thehair.

Abstract

Background: Virtual reality (VR) technology has emerged as an innovative strategy for nursing education, offering immersive and interactive simulations that replicate real patient experiences in a controlled environment. This study aims to evaluate the effect of a Mechanical Ventilator Educational Program Via Immersive Virtual Reality Strategy on the knowledge and skills of nursing students in AAUP-Palestine.

Method: The quasi-experimental study used a self-administered questionnaire to obtain objective and statistical data on AAUP nursing students' mechanical ventilation knowledge and skills. Included 80 nursing students (40 interventional and 40 control groups) selected from Student who have taken a course in advance (MEDICAL3), interventional in Simulation Lab, control group in Lecture in university halls between June 10-20, 2024.

Results: Participants in the interventional and control groups had mean ages of 21.80(±1.22) and 21.74(±1.12), respectively. In a post-test, statistically significant between the intervention and control groups had mean knowledge scores of 4.66(±0.95) and 3.19(±1.05), respectively, regarding mechanical ventilators. The interventional and control groups regarding all the knowledge domains in a post-test (p-value<0.05). All mean scores in the interventional group were higher mean score levels than the control group. In contrast, there was no statistically significant between the interventional and control groups regarding the skills level in the post-test (P-value= 0.35). A statistically significant change was seen between the interventional group's pre- and post-test knowledge of mechanical ventilators.

Conclusion: This study found that VR teaching programs improve nursing students' mechanical ventilator proficiency. VR-based training improved student’s more than traditional learning. These findings demonstrate that VR may enhance nursing education by delivering immersive experiences. VR's benefits must be maximized by addressing its limitations and improving deployment tactics.

Keywords: Mechanical Ventilator; Educational Program; Virtual Reality; Knowledge; Skills; Nursing Students; and Palestine.

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Abbreviations

Abbreviation	Explanation
AAUP	Arab American University Palestine
ANOVA	Analysis of Variance
ICU	Intensive Care Unit
M	Mean
SD	Standard Deviation
SPSS	Statistical Package for Social Sciences
t-test	T Student Statistical Test
VR	Virtual Reality

Chapter One: Introduction

1.1 Introduction

Nursing students face ongoing challenges in developing innovative and readily available instructional techniques to guide learners throughout their education. In the last decade, particularly during the COVID-19 epidemic and challenges in training nurses, there has been an increase in the application of advanced technology such as VR. "A wide range of computer-based applications frequently associated with immersive, highly visual characteristics that allow the participant to look around and navigate within a seemingly real or physical world" are included in VR (Fealy et al., 2019& Morin, 2020). Virtual reality relies on the concept that a virtual environment can be produced, whether actual or imagined. This enables learners to visualise the information and engage with it, which means that VR technology offers the ability to alter the instruction method (Vlachopoulos and Makri, 2017; Zackoff et al., 2020).

Virtual reality (VR) technology has emerged as an innovative strategy for nursing education,offering immersive and interactive simulations that replicate real patient experiences in a controlled environment (Timmis, 2019). The primary type of care given to individuals with respiratory failure is mechanical ventilation (Lee et al., 2022). Mechanical ventilation, among the most often employed immediate lifesaving technique globally, is utilized on a daily basis for a diverse array of purposes, spanning from regular surgical interventions to cases of severe organ damage. In addition to using preventive ventilation for individuals with healthy lungs, specific mechanical ventilator techniques are defined for certain conditions including as acute lung injury and persistent obstructive pulmonary disease (Pham et al., 2017).

Patients weaning off mechanical ventilation in the intensive care unit may benefit significantly from the strengthening of their inspiratory muscles that is attained by threshold pressure training or ventilator sensitivity modification. These advantages include a better breathing pattern, easier weaning, potential stay reductions, and a shorter duration of non-invasive ventilatory assistance following extubating. When the training is applied to the suitable patients under close supervision and with additional safety measures in place, these advantages can be obtained safely (Elkins and Dentice, 2015). The patient can maintain unaided spontaneous breathing because mechanical ventilation has adequately improved (Girard et al., 2017). Overall, this research aims to fill the existing knowledge gap, provide insights into the use of virtual patients and virtual reality technology in mechanical ventilation, and contribute to advancements.

1.2 Problem Statement

Studies have shown that ICU nurses' knowledge of mechanical ventilation is globally poor. One-third of the patients admitted to the intensive care unit (ICU) in the world need mechanical ventilation (MV) treatment. Mechanical ventilator support is one of the main indications for admission to the intensive care unit (ICU). The traditional methods of teaching mechanical ventilator management often increase the number of students in universities, shortage of clinical sites, and insufficient knowledge and skills among students in intensive care units and how they can use mechanical ventilators required for effective learning.

There is a need for innovative educational approaches that provide nursing students with hands-on experience and decision-making opportunities before encountering actual patients. The use of VR simulations can address this problem by creating a safe and controlled environment where students can repeatedly practice and

discuss clinical decisions related to mechanical ventilators (Jeffries et al., 2016). However, there is a knowledge gap regarding the effectiveness of VR technology in predicting patient complications and its impact on student learning outcomes, particularly within the Palestinian context.

1.3 Objectives of the Study

1.3.1 Main objectives

The main objective of this study is to evaluate the effect of a Mechanical Ventilator Educational Program Via an Immersive VR strategy on the knowledge and skills of nursing students in AAUP- Palestine.

1.3.2 Specific objectives

1. To evaluate the effect of a Mechanical Ventilator Educational Program Via Virtual Reality versus traditional learning on the knowledge and skills of nursing students in AAUP – Palestine.
2. To determine the relationship between demographic data and the knowledge and skills of nursing students in AAUP-Palestine.

1.4 Hypothesis of the study

Null Hypothesis (1) there is no effect of a Mechanical Ventilator Educational Program Via Virtual Reality versus traditional learning on the knowledge and skills of nursing students in AAUP - Palestine.

Null Hypothesis (2) there is no significant deference between VR and education program knowledge and skills of nursing students in AAUP - Palestine.

Null Hypothesis (3) determine the no relationship between demographic data and

the knowledge and skills of nursing students in AAUP - Palestine.

1.5 Research questions

1. What is the effect of a Mechanical Ventilator Educational Program Via Virtual Reality versus traditional learning on the knowledge and skills of nursing students in AAUP Palestine?
2. Is There a significant difference between VR and education program knowledge and skills of nursing students in AAUP Palestine?
3. Is There a relationship between demographic data and the knowledge and skills of nursing students in AAUP Palestine?

1.6 Significance of the Study

There is a knowledge gap regarding the effectiveness of virtual reality (VR) in predicting patient complications and its potential for enhancing learning and practice in the context of mechanical ventilation. There are limited studies about the effectiveness of the VR technique on mechanical ventilators in Palestine. To address this gap, the proposed research aims to contribute to the existing body of knowledge by focusing on the creation of virtual patients in the field of mechanical ventilation. By utilizing virtual patients and personalizing the data, this study intends to address the need for patient-specific predictions and customization, which are crucial for ICU patients with varying conditions and treatment responses.

Previous studies have highlighted the potential benefits of virtual patient models in predicting patient-specific lung mechanics and optimizing mechanical ventilation settings (Zhou et al., 2021). Clinical data and nonlinear mechanics models have been used to develop patient-specific virtual patients that provide accurate predictions of lung

mechanics responses to adjustments in ventilation settings. These virtual patients offer personalized and precise care, leading to improved patient outcomes and cost reduction (Morton et al., 2019).

The American University in Palestine has recently acquired a VR device and aims to explore its potential applications in the scientific and healthcare field. This research focuses on utilizing VR technology to enhance nursing education in Palestine, specifically in the context of mechanical ventilator management. This study will contribute to the existing body of knowledge by examining the effectiveness of VR technology in nursing education, specifically in the field of mechanical ventilator management.

This study aims to assess the effects of VR strategy training on the knowledge and skills of nursing students. The findings will offer valuable insights into the advantages of using VR technology in the nursing curriculum. The results can provide valuable insights to nurse instructors and government officials in Palestine on the efficacy of VR-based teaching, thereby improving the standard of healthcare provision and ensuring patient safety. Furthermore, this study has implications. By identifying areas of concern within clinical practice and providing evidence-based findings, it can contribute to policy development in the field of nursing, particularly in the intensive care area.

The research also aims to explore the potential of virtual patients in facilitating ICU nursing training. By providing a realistic and comprehensive learning experience without the risks associated with actual patients, virtual patients have the potential to reduce costs for universities, students, and patients while enhancing educational outcomes. This aspect of the research is particularly relevant and exciting, as it

addresses the need for innovative and cost-effective educational approaches in the field of mechanical ventilation.

1.7 Conceptual Framework

Figure 1.1 explains the conceptual framework of the study.

The independent variables are demographic data (age, gender, GPA, education years).

(dependent variables), which are skill level and knowledge.

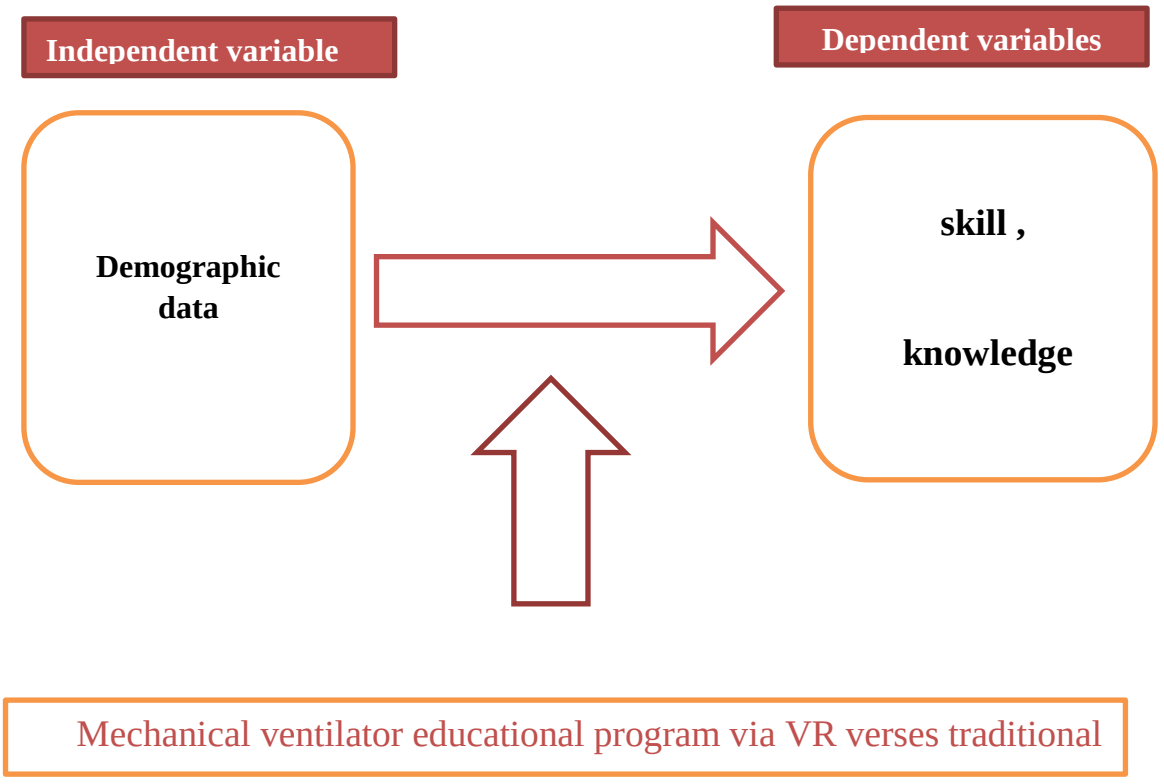

Figure 1.1 explains the conceptual framework

1.8 Conceptual and Operational Definitions

1.8.1 Skill:

The ability to use one's knowledge effectively and readily in execution or performance (Soanes, 2007).Operational definition of skills**,** the practical abiltities, techniques, and competencies that nursing students acquire and demonstrate in mechanical ventilators' effective and safe operation. These skills encompass a range of actions and behaviours, including but not limited to setting up and calibrating ventilator equipment, monitoring patient parameters, troubleshooting issues, adjusting ventilation settings based on patient needs, and responding appropriately to emergencies related to mechanical ventilation.

1.8.2 Knowledge:

The facts, information, and understanding a person has acquired through experience or education (Soanes, 2007).Operational definition of knowledge, the understanding, awareness, and comprehension that nursing students gain through the educational program regarding the theoretical principles, concepts, and practical aspects related to mechanical ventilation. This includes grasping the fundamental principles of ventilator operation, recognizing key components of ventilator settings, understanding the physiological parameters affected by mechanical ventilation, and acquiring knowledge of safety protocols and best practices.

1.8.3 VR:

Virtual Reality (VR) define is a computer-generated immersive experience replicating or simulating real-world environments or situations, typically through specialized headsets and motion-tracking devices (National Research Council, 2018). It allows individuals to interact with a three-dimensional virtual environment and experience a sense of presence and immersion (Slater & Wilbur, 2017). VR technology has gained significant attention and implementation across various domains, including healthcare education.

There are two types of VR immersive and non-immersive have emerged as valuable tools for enhancing students' knowledge and skills in mechanical ventilator management (Johnson et al., 2020). Mechanical ventilation is a critical aspect of patient care, particularly in intensive care units, and its proper management requires proficiency and competence from healthcare professionals, including nursing students. Using VR-based simulations, nursing students can engage in realistic scenarios and practice their skills in a safe and controlled environment.

In nursing education, through VR, nursing students can acquire knowledge of the principles and mechanisms of mechanical ventilation, understand the various ventilation modes, and grasp the implications of different ventilator settings on patient outcomes. VR simulations provide an interactive platform that allows students to manipulate virtual ventilators, adjust settings, and observe changes in patient parameters, such as tidal volume, respiratory rate, and oxygen saturation. This hands-on experience fosters a deeper understanding of mechanical ventilation concepts and enhances students' ability to make informed decisions regarding ventilator management.

Furthermore, VR enables nursing students to develop essential clinical skills, such as airway management, suctioning techniques, and troubleshooting ventilator alarms. By practicing these skills in a virtual environment, students can refine their techniques, receive immediate feedback, and repeat scenarios until proficiency is achieved. VR simulations can present a range of patient conditions and complications, allowing students to experience realistic challenges and develop critical thinking skills in ventilator management.

1.9 Structure of the Thesis

This thesis is structured into five chapters. Chapter 1 presents an overview of the study's subject, including the historical context, the research issue, the goals, and the importance of the investigation. Chapter 2 provides an extensive literature study that explores the current knowledge on client-specific or virtual client modelling for ventilatory support and VR systems for mechanical ventilation. Chapter 3 provides a comprehensive overview of the study technique, encompassing the study's design, sample and subjects, data collecting techniques, analysis of data, and concerns regarding ethics. Chapter 4 provides the findings of the study, which include a detailed examination of the people who participated and a comparison of the knowledge and abilities of the VR-based and traditional schooling groups. Chapter 5 presents the study's results concerning the study's goals, examines their implications for nursing education, offers suggestions for additional studies, recognizes the limits of the research, and ends with the dissertation.

1.10 Chapter Summary

Chapter 1 presented the research issue about the influence of virtual reality (VR) technology on the knowledge and abilities of nursing students in managing mechanical ventilators. The text emphasized the research issue and study goals. The study's importance concerning nursing education and policy creation was also addressed. The subsequent chapters will offer the study methodology, data analysis, and interpretation of results to answer the research goals indicated in this chapter.

Chapter Two: Literature Review

2.1 Introduction

A literature review using Science Direct databases, Google Scholar, and PubMed was performed before the start of the study. Keywords used in the searches involved patient-specific, virtual patients, mechanical ventilation Education Program, Virtual Reality, Knowledge, Skills and Nurses. Studies were selected based on their support for the study.

2.2 Previous Studies

Specifically, research utilising VR in learning about nursing has shown favorable outcomes in therapy proficiency, analytical reasoning, problem-solving capacity, self-confidence, and the level of engagement necessary for mechanical ventilation care (Lee et al., 2022). Compared to conventional training, virtual reality simulation training coupled with technical skill training can enhance the emergency reserve nurses' ability to response. The study's findings support the emergency training of reserve nurses to help them respond to public health emergencies effectively and indicate that this approach merits more investigation and promotion (Rushton et al., 2020).

According to Windisch et al. (2018), the study revealed that Mechanical Ventilation Nursing is a complicated and constantly changing procedure that differs from standard procedures in nursing. It requires extensive knowledge and skills to offer effective respiratory treatment and minimize complications (Windisch et al., 2018).

Furthermore, Urner et al. (2018) recognized the crucial significance of nurses' involvement in administering artificial breathing, while any mishandling of this process poses a rapid and severe risk to the client's survival. In addition, due to the potential fast deterioration of individuals with serious illnesses, nurses must possess the expertise and abilities necessary to utilize mechanical ventilation in various circumstances efficiently. Nurses face difficulty comprehending and providing ventilation-based care within a limited timeframe (Urner et al., 2018).

Using VR technological devices, Chavez et al. (2018) showed how this technology may boost student engagement in practical educational activities by engaging learners in settings as close to their natural environment as practicable (Chavez et al., 2018). According to the findings of a qualitative investigation on the application of VR technology in nursing, learners can connect with elements in particular virtual learning surroundings when VR is paired with conventional nurses' education. This enables students to develop emotions and sensations identical to those in the natural environment. This implies understanding the material they discovered and the best way to utilize that knowledge (Forsberg et al., 2016).

The greater level of conceptual understanding is additionally addressed by Kolb's experiential education model, which argues that learners in nursing gain information from activities in a virtual environment as if they were in real life. Consequently, they acquire more immediate and long-lasting benefits. This framework also explains the higher level of scientific understanding. The application of VR technology in nursing education has the potential to encourage learners in nursing to devote longer to their research, to help them strengthen their expertise and skills, and to establish the

circumstances necessary to facilitate the change between nursing learners from developing centred around information to education depending on competence and expertise (Chan et al., 2012).

Based on the literature (Zhou et al., 2021; Morton et al., 2019; Sun et al., 2022; Morton et al., 2018; Zhou et al., 2022), the key ideas, theories, concepts, and findings related to the research topic of patient-specific or virtual patients for mechanical ventilation can be summarized as follows: Nonlinear Mechanics Model: Zhou et al. (2021) propose a tested nonlinear mechanics model that provides precise predictions of patient-specific lung mechanics response to adjustments in mechanical ventilation settings. This model enables customized, precise care and has demonstrated both mechanical and prediction accuracy.

2.2.1 Effect of VR on Knowledge of Mechanical Ventilation Nursing

Virtual reality can make consolidating previously learned knowledge and abilities easier. Among the most significant proposals was using VR for tests to help students understand before classes, in the intervals among courses and hands-on activities, or following lessons. Several others believed that virtual reality may be used to update the information they had already learned. According to Thompson et al.'s research from 2020, respondents also found VR to be an essential way of promoting equality among learners by providing identical information using the same method. This is particularly relevant when students have restricted or limited access to specific clinical settings. For nurses to successfully handle a client receiving breathing assistance in critical care, they need to have the required information, capabilities, and skills. (Jun et al., 2022) Students, teachers, and nurse practitioners must acquire the information necessary to

manage patients receiving help from a ventilator effectively. Alternatively, virtual reality simulation training can be utilized to accomplish this training.

The findings of the systematic review conducted by Liu et al. (2023) demonstrated that the use of VR technology in the classroom setting of nursing learners could enhance their understanding of theory more efficiently compared to other or conventional nursing methods of instruction. Furthermore, the distinction was found to be of statistical significance ($P < 0.05$). The conceptual program is vital to nursing education since it assures nurses that their understanding can be translated into practical nursing ability. Nursing instructors have implemented virtual reality to enhance the efficacy of the academic training they educate (Liu et al., 2023).

Lee et al. (2022) investigated the knowledge of ventilation therapy nursing in two groups: the experimental group, to whom the virtual reality simulation program for mechanical ventilator nursing was applied, and the control group. The researchers found a substantial difference between the two groups depending on their starting point. On the other hand, the interaction impact between each group and the periods did not differ significantly (Lee et al., 2022).

There was an analysis of variance with a p-value (0.05) about nurses' knowledge of mechanical ventilation concerning such a group of clients, according to the results of an investigation conducted in Egypt by Mohamed et al. (2019). The researchers found that the understanding level of healthcare professionals before and after introducing a virtual reality simulation program displayed an essential variation in mechanical ventilation knowledge for this particular category of clients.

Following the learning program, almost all of the nurses who participated in the

study provided acceptable responses, with 84% being satisfied. This contrasts with the 44% of nurses who responded well before the training program. Before implementing the program, nurses could correctly identify the meaning of MV and its applications and consequences (76%, 70%, and 62%, specifically). Nevertheless, following the program, they could accurately identify MVs with 100 percent, 96 percent, and 82 percent accuracy, with substantial variations (p 0.05). In addition, the responses of nurses about the setup of the ventilator, the methods and warnings of the mechanical ventilation, and the problems of the positive end-expiratory pressure (PEEP) were accurate in 58%, 42%, 32%, and 72% of instances, accordingly, prior to the program. However, following the program, the responses were accurate in 86%, 88%, 64%, 80%, and 98% of cases, respectively. On the other hand, the replies of twenty percent of nurses about the reasons for the increased alarms were accurately preceding the program. In comparison, sixty-two percent of their responses were acceptable after the program (Mohamed et al., 2019).

Nurses need to have a comprehensive understanding of the functioning and constraints of ventilator settings. Nurses need to have a comprehensive understanding of the essential aspects of ventilation assistance, encompassing ventilator styles, environments, and warnings. The program brochure included a concise summary of the often-used ventilation modes and their fundamental functioning. Readers who wanted more detailed information were referred to other sources **(Aknc et al., 2010).** In contrast, Stepan et al. (2017) found that there was no meaningful disparity in knowledge ratings between the treatment group, which utilized VR a simulation, and the nonintervention group, which relied on manual information, in the context of neurological anatomy instruction for medical learners (Stepan et al., 2017).

Contrary to a different investigation, which found that nurses in Taiwan who were provided with learning resources including VR for chemotherapeutic delivery exhibited higher understanding compared to the control group (Jung et al., 2022). Nevertheless, based on the findings of a study conducted by Woon et al. (2021), it was shown that VR instruction can effectively impart procedural understanding to learners through independent instructional meetings lasting 30 minutes, with a moderate level of submersion. To further validate the efficacy of the program, future studies should focus on expanding the number of educational meetings.

2.2.2 Effect of VR on Skills

The effect of VR is advisable to enhance the technological efficacy of the VR education setting in the coming years, along with augmenting proficiency in transferring the acquired functional skills from the simulated VR system to clinical settings. Enabling nurses to engage with individuals in a virtual setting may improve their understanding of practical skills and exposure to practical situations throughout the application. Additionally, specific procedures that can't be done on real clients can be practiced in a virtual setting. This helps expedite the transition from concept to implementation, from being a student of nursing to becoming a registered nurse, as well as from class education to practical use.

The applied services of nursing instruction with VR applied to education fluctuate from traditional or other nursing education approaches. Virtual simulation technology can vividly demonstrate the operation's specifics and assist students in understanding and mastering the material more quickly and thoroughly, hence improving the educational impact (Choi et al., 2017). The VR may strengthen the connection between

theoretical concepts and practical applications for learners. This is achieved by providing learners with continuous contact with information and relevant practical skills, which in turn improves their ability to retain knowledge and acquire new abilities. (Jenson & Forsyth, 2012).

Four studies conducted by Yuan et al. (2019), Ping et al. (2017), Liping et al. (2017), and Nan Cao (2021) assessed the efficacy of VR devices for enhancing functional abilities. The findings indicated that there had been no variation in the investigations that participated in (P = 0.34, I2 = 10%), hence a fixed-effects approach was employed. The aggregated findings demonstrated a significant disparity in comparison with various conventional approaches for nursing instruction (Yuan et al., 2019; Ping et al., 2017; Liping et al., 2017; & Nan Cao, 2021). Jefferson (2022) created a high-fidelity simulation (HFS) training that resulted in enhanced learning persistence for students (Jefferson, 2022).

The research investigation conducted by Mohamed et al. (2019) in Egypt demonstrated that there were significant variations in the overall rating for the nurses' behavior levels during the initial test and afterward. These variations indicate that the nurses' job performance improved significantly following the training program compared to their performance before the program (Mohamed et al., 2019). According to Salameh et al. (2021), the COVID-19 pandemic has increased demand for ventilation devices. As a result, nurses have been exposed to circumstances where it is necessary to use ventilatory support for clients. This exposure has provided them with valuable real-world practical knowledge they hadn't previously experienced. The researchers indicate that such experiences can effectively enhance the clinical reasoning skills of nursing

students (Salameh et al., 2021).

The research conducted by Schroedl et al. (2011) revealed that using simulation training enhances trainees' understanding and proficiency in handling frequent issues in the MICU, including ventilatory therapy and obtrusive cardiac monitor. More precisely, the implementation of a standardized training program enhanced trainees' comprehension and practical proficiency, which was evaluated by an in-hospital competencies evaluation. The residents universally received the educational program (Schroedl et al., 2011).

2.2.3 Effect on others of VR

2.2.3.1 Effect of VR technology on nursing students' academic satisfaction

The captivating and innovative quality of virtual reality, which, from their perspective, heightened their drive and rendered the educational process more intriguing. Furthermore, VR can enhance the learning experience by creating an engaging and immersive environment. This immersive experience profoundly impacts nursing students, stimulating their senses and fostering their excitement and active engagement in the learning process. Consequently, nursing students have been capable of fully establishing themselves as active learners (Kang et al., 2020). According to Chang et al. (2020), VR in nursing education enhances the visual representation of instructional information, increases nursing students' motivation for autonomous learning, transforms education from an introspective to an engaged process, and allows for the practice of operational abilities in virtual environments. Within the virtual setting, individuals not only enhance their operating abilities but also develop their mental health and judgement capacity, as well as their capacity to handle actual clinical

issues (Chang et al., 2020).

Jun'e et al. (2010) discovered that virtual reality offers a practical, interactive educational setting for educators and learners to share information. They discovered that instructors and learners utilize VR to enhance analyzing problems and conceptualization through group discussions and collaborations. This helps students develop their collaborative interpersonal competencies, problem-solving abilities, and judgment skills, ultimately leading to increased academic satisfaction among learners in nursing (Jun'e et al., 2010).

The study by Lee et al. (2022) found that the treatment group, which received ventilation through a healthcare VR modelling program, had a considerably greater degree of educational satisfaction than the control population ($t=-3.49$, $p=.001$). This supports the conclusion that the two groups had variations regarding educational satisfaction. Research done on 27 RN-BSN nursing learners in the US found that the experimental group had greater satisfaction levels than the control group (Turrise et al., 2020).

Furthermore, it aligns with an additional investigation conducted by Chan et al. (2021), which utilized a VR nursing teaching program incorporating a portable head-mounted screen with an integrated chemotherapy port. This investigation found a notable disparity in clinical satisfaction between the group that received the treatment and the group that did not. The learning initiative's success may be attributed to its careful consideration of the student's needs for learning and its practical implementation of actual situations and healthcare settings that were both clinically and educationally relevant (Chan et al., 2021). The research conducted by Cook et al. (2012) revealed that

increased contentment with simulated instruction positively impacted desire and, as a result, improved clinical results. This finding confirms that the program designed in the research benefited learners' abilities.

The research study conducted by Kim and Ahn (2021) revealed that using virtual reality media significantly impacted educational results and student happiness, as indicated by the favourable evaluations of 4.07 out of 5 and 4.14 out of 5, respectively. This aligns with the findings of a review of the literature conducted by Yoo et al. (2018), which demonstrated that virtual reality-based development substantially impacts the study. Additionally, an investigation by Vidal et al. (2013) showed that electronic reality-based instruction leads to a favourable and significantly high level of student contentment (Kim & Ahn, 2021; Yoo et al., 2018; Vidal et al., 2013). A previous investigation indicates that virtually reality-based education yields no discernible distinction in learning outcomes compared to conventional learning approaches. Previous investigations have shown that virtual reality-based education has a significant impact. Combining conventional educational techniques with virtually reality-based instruction may further boost learning effectiveness (Tark & Yoo, 2018).

Kim et al. (2021) conducted an investigation that found that male learners had considerably better satisfaction with augmented reality equipment than female learners, based on the general demographics of the respondents. This finding aligns with the research outcome of a prior study conducted by Tark et al. (2018), which showed that male students experienced a more significant role than female students in innovative converging classrooms utilizing augmented reality-producing systems. These findings align with Sung's (2018) study, which revealed that male learners were more inclined to engage and thrive in active educational settings, whilst female students preferred a less

unpredictable educational setting. Consequently, when incorporating virtual reality devices into education, providing female students with a sequential learning process could be beneficial. This may be accomplished by engaging them with content that aligns with their academic focus, such as activities associated with their field of study (Kim et al., 2021 & Tark et al., 2018 & Sung, 2018).

2.2.3.2 Effect of VR technology on nursing students' Performance

Despite the numerous benefits of VR, multiple studies have shown that VR is not superior to conventional techniques regarding specific results, including knowledge acquisition and academic ratings. There are still discrepancies in the research about the efficacy of virtual reality. New meta-analyses have been carried out to assess the efficacy of VR in specific domains of medicine and teaching (Farra et al., 2015 & Neguț et al., 2016).

The findings of Chen et al. (2020) research indicated that VR did not demonstrate superior efficacy in lowering performing time compared to alternative instructional approaches. Despite implementing an analysis of sensitivity using the leave-one-out technique, the research nevertheless found substantial variability among the research designs. The variation noted in the studies selected could be attributed to the varied study procedures employed, including operational initiatives, VR technologies, and teaching tactics in the controls (Chen et al., 2020).

Despite the limited reliability of the verification, research examining the effectiveness of VR endoscopy simulation instruction found no discernible disparity in learning time between the VR and the control teams. This study had a sufficient amount of information to support its findings. Conversely, research in clinical care found that

VR can help workers decrease the time it takes to complete tasks (Khan et al., 2018). Studies contrasting VR simulation instruction with traditional patient-based education found small variations in performance period (the time taken to complete the assessment task(s)) between the VR training group and the traditional education team (Ende, 2012 & Haycock, 2010).

Yu et al. (2020) performed an investigation focused on experimental investigations from 2016 to 2019 to verify the impact of teaching nursing by employing VR.The investigation found that achievement, self-confidence, and educational happiness substantially improved. Following the implementation of our VR simulating program, the participants in the experiment saw a substantial rise in their ratings of achievement self-confidence. The average score rose from 5.36 to 8.57 (out of 10), a more significant rise than compared to those in the control group (Yu et al., 2020).

2.2.3.3 Effect of VR technology on the level of critical thinking of nursing students

Critical thinking is a method of problem-solving or answering inquiries with limited information. Thinking critically is a significant area of focus in learning, especially in the 21st century. Considerable attention has been given to how students' educational outcomes are influenced by their critical thinking ability. Investigators prioritise mimicked classrooms due to the rapid development of virtual reality equipment. The aim is to employ this environment to foster the growth and progression of critical thinking skills in undergraduates (Khan et al., 2018).

Nurse simulators have incorporated the utilizations of a human-patient emulator

or standardized client. Simulator learning enables learners in nursing to promptly obtain evaluations on their procedures, leading to enhanced nursing abilities and greater trust. In addition, they can enhance their ability to think critically (Cobbett et al., 2016). Kang (2020) conducted a study in which a simulated nursing program was created to investigate the practicality and efficacy of virtual simulation on learners in nursing. The study aimed to assess the influence of electronic modelling on their critical thinking and self-directed educational abilities. The findings revealed that the simulated reality direction enhanced the critical thinking abilities of learners and their capacity to acquire knowledge independently. However, it should be noted that the improvement in thinking critically attitude was not statistically noteworthy (Kang et al., 2020).

According to Kandi et al. (2020), learners who participate in virtual classroom programs can improve their planning, assessment, and creativity abilities. This finding was determined using a pilot study. Additionally, the research discovered that an augmented reality architectural simulation facilitated learners to recognize a more significant number of design flaws and achieve higher scores on following critical thinking assessments (Kandi et al., 2020).

The investigation conducted by Liu et al. (2023) found no significant distinction in the enhancement level of fulfilment in the training of nurses when using VR technological devices. This absence of variations can be attributed to inadequate studies on the connection between online educational settings and college learners' acquisition of intellectual abilities. Additionally, there is a lack of clarity regarding the variables influencing the growth. Of essential thinking skills in undergraduates within the context of virtual learning. Furthermore, the procedures by which every influence provides a part and the degree to which each factor contributes are not well understood at first.

The unresolved issues pertain to the extent of impact exerted by each affecting element (Liu et al., 2023).

Nevertheless, online educational settings present challenges like data uncertainty and overbearing mental workload. Therefore, it is imperative to meticulously plan online developing circumstances to facilitate the growth and improvement of higher education students' critical thinking skills (Liu et al., 2023).

2.2.3.4 Impact of virtual reality simulations on patient safety

Ensuring patient safety involves the eradication of avoidable medical mistakes that result in damage to clients. Ensuring the safety of patients is contingent upon receiving a nursing education of the highest standard. Modelling, as a whole, and VR, specifically, enhance the calibre of nursing instruction by allowing participants to apply theoretical knowledge and cultivate practical abilities and constructive mindsets. According to Butt et al. (2018), these students have a greater inclined to take patient safety into account when carrying out clinical tasks.

Studies indicate that students who have acquired essential nursing abilities in simulations are prone to greater ease and confidence, reducing the potential damage that may arise from treatments in real-world clinical settings. An illustration of this is the Tag Team Patient Safety Simulation (TTPSS), which improved the understanding and abilities of college nurses, enabling them to deliver effective care. VR training exercises must prioritise the fundamentals of patient safety to effectively instruct students on delivering secure healthcare in clinical settings (Bayram & Caliskan, 2019).

Virtual reality simulators with speech capabilities empower learners to collaborate while rendering precise and quick clinical judgments. Likewise, interacting with virtual

patients enhances students' ability to communicate effectively. The VR may be an instructional tool to educate students on several aspects of medical care, including acquiring medical records, greeting clients at the clinic, executing release protocols procedures, and facilitating communication with other healthcare providers. Virtual reality simulations provide students with dynamic learning experiences and valuable feedback to enhance their learning process. Virtual reality simulations focusing on intravenous drug administration and distribution enhance students' proficiency in properly administering drugs (Smith & Hamilton, 2015).

Dubovi et al. (2020) discovered that nursing students who engaged in a VR simulation acquired a high level of knowledge regarding handling medications. Additionally, it was observed that a virtual reality simulation facilitated the acquisition of information among nursing learners about the essential concepts of infection, catheterization of the urinary system, and handling medications. A study revealed that a virtual reality simulation's utilisation enhanced intravenous medication infusion abilities among nursing learners. VR simulations instruct nursing students in identifying potential issues following medication delivery. For instance, nursing students demonstrated a higher rate of succeeding in IV treatments with fewer attempts, caused less discomfort to clients, and reported reduced haemorrhage development following their involvement in a VR simulation (Dubovi et al., 2020).

Virtual reality simulation can facilitate the cultivation of positive feelings among nurses regarding cleanliness, leading to a decrease in the incidence of infections. Hand hygiene is the most efficacious method for preventing the transmission of illnesses. Nakamura et al. discovered that implementing training exercises increased students' consciousness regarding hand cleanliness and decreased the occurrence of

catheterization infections. The VR simulators enhance students' understanding and proficiency in cleaning, urine, injectable procedures, port catheter injections, tracheostomy suction and treatment, and nasogastric (NG) placement of tubes (Nakamura et al., 2020).

Registered nurses are responsible for delivering safe care, which serves as an indicator of the quality of care. Consequently, virtual reality simulations are employed to instruct them. Biyik Bayram and Caliskan implemented a breathing tube maintenance situation requiring the learner to bring down the bed's rails earlier than the treatment and elevate them afterwards. Failure to accomplish this phase failed to fulfil the task. The exercises instruct learners on the specific preventative measures to be taken to avoid accidents. Other studies showed reduced patient injuries in clinics when nurses were engaged in virtual scenarios (Biyik Bayram & Caliskan, 2018; Bursiek et al., 2016).

Chapter Three: Methodology

3.1 Introduction

This chapter provides a comprehensive overview of the research methodologies used in the study. It covers several aspects such as the research design, phases of questionnaire design, setting, population and sample, study tools, data collecting processes, measures, data analysis, and ethical considerations. Research techniques should be designed to address the research questions and ultimately contribute to accomplishing the study objectives.

3.2 Study design and Setting

This research design is based on a quasi-experiment with two groups: an intervention group and a control group before and after the intervention. The prefix quasi means “resembling.” Thus quasi-experimental research is research that resembles experimental research but is not true experimental research. Although the independent variable is manipulated, participants are not randomly assigned to conditions or orders of conditions (Cook & Campbell, 1979).

3.2.1 Setting

The Virtual reality (VR) technology was conducted in the hall in the Faculty of nursing at AAUP University in Palestine.

3.3 Sampling Method

The sampling method used in this study was the convenience sampling method.

3.3.1 Study Population and Sample

The whole population had 550 students of 3rd and 4th students who enrolled advanced medical 3 courses.

3.3.2 Sample Size Calculation

The sample size was 80 student (40 student intervention and 40 student control), calculated using an online sample size calculator (OpenEpi),Version 3 with a Confidence Level of 95% and Absolute Precision of 5%, the calculated sample size was 70 then in addition 10% dropout ,total minimum calculated sample size 77. The participants were distributed as randomized through the computerize system in the Faculty of nursing in the university.

3.3.3 Inclusion and Exclusion Criteria

3.3.3.1 Inclusion Criteria

- Student AAUP who had taken a course advanced (MEDICAL 3) cores.
- Male and female students
- The nursing student as first time taken the VR and enrolled practice.
- The students didn’t receive training.
- The students achieved homogeneity of study.

3.3.3.2 Exclusion Criteria

- Nurses Student AAUP suffered VR symptoms such as Dizziness, sickness of motion, and blurry hat prevented them from using the VR oculus.

- Nurse Student AAUP who had not taken a course in advance (MEDICAL 3) cores.
- Nurse Student AAUP Receiving training about Mechanical Ventilators.

3.4 Study Instrument

Questionnaires were used to collect the data from the participants. The questionnaire consisted of Two:

3.4.1 Demographic data

Developed by the researchers after critically reviewing the literature (Hassen et al., 2023). It includes nine questions (age, gender, GPA, education years, knowledge about mechanical ventilation, receiving training about mechanical ventilation, duration of training).

3.4.2 Knowledge and Skills Part

Developed by the researchers after critically reviewing the literature (Hassen et al., 2023; Saritas, Kaya & Dolanbay, 2019). The questions were answered by yes, no or do not know. This part consisted of 3 sections, including knowledge about Mechanical ventilators, 8 questions, knowledge about Endotracheal Intubation, 5 questions; knowledge of mechanical ventilation settings based on Arterial Blood gases (Abgs), 5 questions, and Suctioning procedures 5 questions. The skills questionaaire contained 11 items. The five Likert scale the answer options were always, often, sometimes, rarely, and never. Hassen et al., 2023).

3.5 The Pilot Study

Pilot research was undertaken to assess the readability and utility of the research's instruments, as well as to recognize any anticipated issues or challenges in the process of gathering data and to determine the appropriateness of the survey responses. Their remarks indicated that the things were unambiguous, not perplexing, all-encompassing, appropriate, and straightforward. The pilot study was conducted with VR student nurses to obtain their feedback on the VR technology. A preliminary study was done before commencing the primary investigation. The survey required around 10 to 15 minutes to complete. Those who participated in the pilot study total 70 (10%) in sample size excluded from the main study. Two experts in nursing sciences education and one technical expert evaluated our program. The Cronbach's alpha (0.81) coefficient was computed for each of the subscales in the Scales.

3.6 Data Collection Procedures

The data was gathered during the data collection procedure through questionnaires, which participants completed. All questionnaires were distributed to target participants. Each participant was given a detailed description of the study's objectives and enough time to fill out questionnaires. The study's aim was explained to all participants, and informed consent was signed before completing the questionnaire. Nursing students were informed about voluntary engagement. That wasn't anonymous about the participants. All information was kept confidential and was only used for research purposes. All participants were ensured confidentiality and privacy. Data was collected to be used as study material. Participation was optional, and the participants had the right to withdraw at any moment if they could not finish the questionnaire.

Participation in this study was free.

3.7 Data Analysis

The data were analyzed using the Statistical Package for Social Sciences 26.0 (SPSSIBM Corp., Armonk, NY, USA) software programme to examine the relationship between the study variables. The descriptive statistics analysis involved calculating the Mean (M), percentage, range, and standard deviation (SD) for numerical data, while categorical data was analyzed using numbers and percentages. The statistical analyses employed in the study were independent t-test, one-way ANOVA, and correlation. Statistical significance was attributed to p-values less than 0.05.

3.8 Ethical Consideration

The researcher committed to all ethical considerations required to conduct research. The AAUP committee obtained ethical approval from the University IRB in Ramallah (code number 2023/A/85/N).

3.9 Summary

Data was collected by utilizing a self-administered questionnaire. Quantitative research descriptive cross-sectional design consisting of a self-administered questionnaire and a checklist to collect data about mechanical ventilation knowledge and skills among student nursing in AUUP. Via quasi-experiment, two group was pre- and post-group. Participants in this study were selected from Student AAUP who have taken a course in advanced (MEDICAL3) cores.

Chapter Four: Results

4.1 Introduction

The quasi-experimental study was conducted on 80 students (40 in the interventional group and 40 in the control group). The results chapter provides a thorough analysis of the collected data to evaluate the influence of the educational intervention. This chapter comprehensively analyses the statistical results about enhancing knowledge and skills among nursing students who took part in the virtual reality program. The key findings demonstrate substantial improvements in test scores and practical assessments, underscoring the efficacy of the virtual reality technology curriculum. The chapter also examines the students' feedback and degree of involvement, offering a comprehensive assessment of how virtual reality, as a teaching tool, might improve learning outcomes in mechanical ventilation. Moreover, this text examines the advantages and possibilities of using virtual reality (VR) in nursing education by comparing it to traditional teaching approaches.

4.2 Socio-Demographic Information

The main results showed that the age of the studied participants was a mean value of 21.80 (±1.22) among the intervention group and 21.74 (±1.12) in the control group. Regarding gender, 32.5% were males and 67.5% were females in interventional and control groups. Regarding the education level, the majority of participants, 38(95.0%), had the 4th year in the interventional group and 34 (85.0%) in the control group. The mean scores of GPA were 3.22 (±0.66) and 3.20(±0.41) among interventional and control groups, respectively (Table 4.1).

Table 4.1: Socio-demographic data among the interventional and control groups

Demographic data	Intervention group (n =40)		Control group (n=40)	
	No.	%	No.	%
Age/year **Mean ± SD**	21.80 +1.22		21.74 +1.12	
Gander **Male**	13	32.5%	13	32.5%
Female	27	67.5%	27	67.5%
Educational level **Third level**	2	5.0%	6	15.0%
Fourth level	38	95.0%	34	85.0%
GPA **Mean ± SD**	3.22 + 0.66		3.20 + 0.41	

4.3 Comparison between Knowledge and skills levels in a pre-test among intervention group and control group

Table (4.3) revealed no statistically significant difference between the interventional and control groups regarding the knowledge domains and skills in the pre-test. The majority of the intervention and the control groups answered accurate answers.

Table (4.2: Knowledge domains and skills levels in a pre-test among the intervention group and control group

Knowledge Domains and Skills in both groups	**Intervention group (n=40)**	**Control group (n=40)**	**(p-value)**
	Mean Score (±SD)	**Mean Score (±SD)**	
Knowledge score	3.29(±1.27)	3.15(±1.36)	(0.69)
Skills	47.25(±6.21)	47.50(±5.50)	(0.89)

4.4 Comparison between Knowledge and skills levels in a post-test among intervention group and control group

Table (4.4) revealed a statistically significant difference between the interventional and control groups regarding all the knowledge domains in a post-test (p-value<0.05). All mean scores in the interventional group were higher mean score levels than the control group. In contrast, there was no statistically significant between the interventional and control groups regarding the skills level in the post-test

(P-value= 0.35).

Table (4.3): Knowledge and skills levels in a post-test among the intervention group and control group

Knowledge Domains and Skills in both groups	**Intervention group (n=40) Mean Score (±SD)**	**Control group (n=40) Mean Score (±SD)**	**(p-value)**
Knowledge Domains	4.66 (±0.95)	3.19(±1.05)	**(0.001)***
Skills	52.14(±3.75)	50.92(±9.90)	(0.35)

4.5 Comparison between Knowledge and skills levels in a pre-test and post-test among the intervention group and control group

Table (4.5) revealed a statistically significant difference between the pre-and post-tests among the interventional group regarding the knowledge domains and skills (p-vealus<0.05). The post-test results are better than the pre-test. Also, the pre-test result in skills level was 47.25(±6.21), and the total mean score in the post-test was 52.14(±3.75) (p-value=0.001).

Table (4.5) revealed no statistically significant difference between the pre-test and post-test among the control group regarding the knowledge domains (p-value>0.05). Most studied participants answered the same in the post-test as in the pre-test among the control group. Also, there was no statistically significant difference between the pre-test and post-test in the skills total mean score among the control group.

Table (4.4): Knowledge and skills levels in a pre-test and post-test among the intervention and control groups

Knowledge Domains and Skills in the Intervention Group	**Intervention group**			**Control group**		
	Pre-test (n=40) Mean Score (±SD)	**Post-test (n=40) Mean Score (±SD)**	**(p-value)**	**Pre-test (n=40) Mean Score (±SD)**	**post-test (n=40) Mean Score (±SD)**	**(p-value)**
Knowledge Domains	3.29(+1.27)	4.66 (±0.95)	**(0.001)***	3.15(+1.36)	3.19(±1.05)	(0.14)
Skills	47.25(+6.21)	52.14(±3.75)	**(0.001)***	47.50(±5.50)	50.92(±9.90)	(0.28)

4.6 Regression analysis to predict factors affecting the total score knowledge and skills levels in the post-test

Table (4.6) revealed a significant predictor model with R Square = 0.231, which means these factors' effects equal 23.1%. It was also found that the educational level was the significant predictor factor affecting the mean of total score knowledge level (p.value = 0.001). Additionally, it had the lightest value in beta (0.319), which means that it had the highest effect on the knowledge level, as an increase in the educational level by 0.319 led to an increase in the knowledge level by one unit. Meanwhile, the other mentioned variables had no statistically significant predictor factor affecting the mean score of the total score knowledge level.

Table (4.5): multiple linear regression analysis to predict factors affecting the total score knowledge level in the post-test

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**	**F**	**P value**
1	.480	.231	.143	1.93	2.60	**0.038***
a. Predictors: (Constant), GPA, Education years, Age, Gender						

Coefficients

Model		**Standardized Coefficients**	**t**	**Sig.**
		Beta		
	Gender	-0.124	-0.764	0.450
	Age	-0.305	-2.032	0.050
	Education years	0.319	2.124	**0.041***
	GPA	-0.067	-0.416	0.680

Table (4.7) revealed a significant predictor model with R Square = 0.234, which means these factors' effects equal 23.4%. It was also found that age was the significant predictor factor affecting the mean total score of the skills (p. value = 0.008). Additionally, it had the lightest value in beta (0.418), which means that it had the highest effect on the skills level, as an increase in age by 0.418 led to an increase in the skills level by one unit. Meanwhile, the other mentioned variables had no statistically significant predictor factor affecting the mean total score of practising the skills.

Table (4.6): multiple linear regression analysis to predict factors affecting the total score the skills in the post-test

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	F	P value
1	0.484	0.234	0.147	3.46	2.68	**0.042***
a. Predictors: (Constant), GPA, Education years, Age, Gender						

Coefficients

Model		Standardized Coefficients	T	Sig.
		Beta		
	Gender	0.119	.734	0.468
	Age	0.418	-2.797	**0.008***
	Education years	0.131	-.873	0.389
	GPA	0.268	-1.670	0.104

Chapter Five: Discussion

5.1 Introduction

This chapter review the impact of a virtual reality-based instructional program on nursing students' knowledge and abilities concerning mechanical ventilators. The text examines the importance of the findings, highlighting advancements in both theoretical comprehension and practical utilization among the participants. Comparisons are made between immersive learning environments and standard educational techniques, emphasizing the benefits of the former. In addition, the chapter discusses possible constraints, consequences for future educational methods, and recommendations for additional studies to improve the training of nursing workers in critical care environments. Lastly, the chapter discusses the conclusion of the study.

5.2 Discussion of the Result

5.2.1 The effect of Immersive VR on knowledge

The study was conducted in Palestine to assess the efficacy of a virtual reality (VR) program in enhancing comprehension of mechanical ventilation nursing. The participants were categorized into two groups: an experimental group, which underwent VR training,and a control group,Traditional.The initial assessments revealed a markedly elevated level of knowledge and skills in the experimental group, suggesting that the virtual reality software offered a more thorough and captivating learning approach than conventional methods. The study found that the experimental group showed more significant progress when comparing the pre-test and post-test findings. These findings indicate that the VR simulation's ability to engage participants fully and involve them

significantly improved their knowledge and skills of mechanical ventilation nursing principles. The significant interaction effect seen across groups and time points suggests that the enhancement resulted from the virtual reality intervention rather than the mere passage of time or natural development in the knowledge and skills of nursing students.

The efficacy of virtual reality simulations can be ascribed to several reasons. The immersive setting actively involves learners to a greater extent, enabling them to engage in repetitive practice and receive rapid feedback. This is essential for achieving proficiency in intricate skills such as mechanical ventilation. Moreover, VR offers a consistent and uniform learning encounter while utilizing visual and spatial learning techniques, augmenting theoretical understanding by providing practical, interactive involvement. These findings emphasize the capacity of VR to transform nursing education and enhance clinical results.

Our findings agree well with a previous study conducted by Stepan et al. (2017), which also found no significant difference in the knowledge scores of groups that participated in virtual reality simulations and those that learned from traditional textbooks. Regarding knowledge acquisition in neuroanatomy education, both studies consistently demonstrated that VR and textbook-based learning provided comparable outcomes. This consistency shows that VR may not be superior to traditional textbook approaches in enhancing knowledge scores among medical students in this subject area despite VR providing an alternate learning method (Stepan et al., 2017).

Another study conducted in Taiwan found that the experimental group, which consisted of nursing students provided with teaching materials incorporating VR for chemotherapy administration, demonstrated significantly higher levels of knowledge

than the control group (Chan, Chang, & Huang, 2021). The study found that using VR for learning improved students' comprehension and memory of intricate chemotherapy administration techniques by providing an engaging and interactive experience. The control group, which utilized conventional teaching techniques such as lectures and textbooks, did not exhibit the same enhancement, underscoring virtual reality's potential advantages in medical education. The results show the efficacy of VR as a potent educational instrument that has the potential to revolutionize the learning process in nursing and other healthcare domains (Chan, Chang, & Huang, 2021).

Utilizing VR in this study was advantageous in improving the theoretical comprehension of both the intervention and control groups. Nevertheless, the level of knowledge among the groups may have differed significantly since the assessment scale only considered the accuracy of their information. Woon et al. (2021) study has shown through their previous research that VR education effectively imparts procedural knowledge to students. This study found that students who participated in self-directed VR learning for 30 minutes and achieved moderate immersion in the learning process had notable enhancements in their procedural knowledge (Woon et al., 2021).

The findings of our investigation revealed a significant discrepancy in the understanding and application of ventilatory environments, as assessed by arterial blood gases (ABGs), between the experimental group, which participated in the mechanical ventilation nurse virtual reality (VR) program, and the control group. The group experimenting performed superiorly, in line with previous study results. Kim et al. (2021) researched South Korea, utilising non-invasive positive pressure ventilation (NPPV) programs to train general ward nurses. Furthermore, their study uncovered that the nurses who took part in the virtual reality (VR) program significantly improved their

comprehension and proficiency in managing ventilation settings, in contrast to those who did not receive simulation instruction. (Kim et al., 2021).

5.2.2 The effect of immersive VR on skills

Moreover, the congruity of our findings with those of Son et al. (2018) provides additional evidence for the efficacy of VR simulation in nursing education. Son et al.'s (2018) study used simulations to investigate the effectiveness of training in managing chronic obstructive pulmonary disease (COPD) and congestive heart failure. The results showed that participants who completed simulation-based training had better skills how in managing these illnesses than those who received only traditional instruction. The findings indicate that virtual reality simulations offer a valuable and immersive learning experience that improves theoretical practical skills in different medical and nursing settings.

Our study included comprehensive inquiries on encountering and resolving different problem circumstances in mechanical ventilation settings, specifically focused on arterial blood gases (ABGs) nursing, using VR simulation. This method enabled nursing students to actively participate in genuine clinical situations and use their skills in a controlled and immersive setting. Through the utilization of VR in nursing performance, students are likely to have cultivated enhanced self-assurance and conviction in their capacity to execute particular duties associated with mechanical ventilation effectively.

The findings mentioned above are corroborated by prior research studies conducted by Chae et al. (2015) and Reinhardt et al. (2012). These studies conclusively showed that VR education substantially impacted the objective nursing performance

concerning mechanical ventilation settings, as measured by arterial blood gas (ABG) analysis. According to Chae et al. (2015), nursing students who took part in simulation-based training demonstrated improved proficiency in managing ventilation settings and interpreting ABG data compared to those who received conventional instruction. Reinhardt et al. (2012) found that simulation education significantly enhanced the practical skills of nurses, allowing them to handle intricate mechanical ventilation situations better.

The results of our study are consistent with previous research, indicating that VR simulation instruction is a highly efficient approach to improving the practical skills of nursing students in mechanical ventilation (Ma & Yang, 2020; Lim & Yeom, 2020). The immersive nature of VR enables students to encounter and tackle real-world difficulties within a secure and regulated environment, strengthening their learning and enhancing their self-assurance. This pedagogical method facilitates the connection between theoretical skills and practical implementation and equips students with enhanced competence to manage critical clinical scenarios. Considering the favourable outcomes, integrating VR simulation into the nursing curriculum could effectively enhance the overall calibre of nursing education.

5.2.3. The relationship between demographic students and using VR

Our study results indicate that educational years are associated with the average overall skills score. These findings are consistent with the study by Liu et al. (2023), which showed that individuals with higher levels of education have better skills in complicated clinical ideas, such as mechanical breathing. Another study conducted by Jeong, Lee, and Han (2022) discovered that students with higher levels of education had enhanced proficiency knowledge and skills in managing critical care equipment after

undergoing VR training. Our findings align with another research study, indicating that as nursing students advance intellectually, their capacity to comprehend and utilize knowledge and technical skills, such as operating mechanical ventilators, is greatly improved (Merchant et al., 2014).

Our study revealed that age substantially impacted the average total score of participants' skills in using mechanical ventilators. This finding is consistent with other prior research conducted in nursing education. A study conducted by Kiegaldie and Shaw (2023) found that older nursing students frequently exhibit greater competency in practical skills due to their heightened life experience and maturity. These factors contribute to improved critical thinking and problem-solving capabilities. Moreover, a study conducted by Saab et al. (2021) revealed that older students exhibited superior practical skills proficiency in simulation-based training about mechanical ventilation compared to their younger peers. Another study conducted by Ma et al. (2024) provided more evidence to corroborate this tendency, observing that older nursing students frequently show more skills in mechanical ventilation post-use of the VR procedure.

5.3 Strengths and Limitations

The essential strength of this study is its creative utilization of VR technology to improve the educational experience of nursing students. By incorporating VR into the curriculum, the study created a deeply engaging and interactive learning environment. It enabled students to safely and effectively practice and improve their abilities without the potential dangers of real-life clinical practice. Furthermore, the study's methodological solid design, which incorporates a substantial sample size and careful statistical analysis, enhances the credibility and dependability of the results. The emphasis on both the acquisition of knowledge and the development of practical skills

provides a thorough assessment of the effectiveness of the educational program. This information has the potential to inform similar educational projects worldwide.

Although this study has limitations, it is essential to acknowledge its various shortcomings. A notable constraint is the comparatively brief intervention timeframe, which would not adequately encompass the long-term preservation of knowledge and abilities. Furthermore, the research was conducted exclusively at one establishment, restricting the results' applicability to different educational environments or geographical areas. The utilization of self-reported metrics for some regions of skill assessment may induce bias since individuals may overstate their competencies. In addition, VR technology as an educational tool may have been hindered by technical difficulties and discrepancies in students' familiarity with VR, impacting their learning experiences and results. Furthermore, the study failed to consider additional potential confounding factors, such as previous healthcare exposure or individual cognitive preferences, which may impact the efficacy of the virtual reality instructional program.

5.4 Recommendations

1. Subsequent research should incorporate interventions of longer duration to more effectively evaluate the long-term retention of information and abilities, guaranteeing the enduring educational advantages of virtual reality.
2. Research in RCT.
3. Future research follow-up.
4. Deliver extensive training and assistance to students and teachers about using VR technology, guaranteeing that technical obstacles do not impede the learning process and that all participants can actively utilize the educational tool.

5. Suggest faculties and nurse educators integrate it into the nursing curriculum as a teaching strategy.
6. Cooperate multidisciplinary to develop more procedures and skills in several courses in the nursing program.

5.5 Implication

1. Integrate virtual reality (VR) technology with traditional teaching methods to develop a hybrid educational approach that capitalizes on the advantages of both. This has the potential to improve learning outcomes for nursing students.
2. Integrate objective skill assessment methods, such as direct observation and performance evaluations conducted by clinical instructors, to mitigate the possible bias of self-reported data.
3. Integrate virtual reality (VR) technology with new nursing education and simulation lab in the university this has the potential to improve learning outcomes for nursing students.

5.6 Conclusion

The study findings indicate that introducing a VR instructional program substantially impacts nursing students' knowledge and practical skills in operating mechanical ventilators. The results suggest that students who engaged in VR-based training showed significant enhancements in both information acquisition and skill performance, in contrast to those who received conventional instruction. The study found that age was a significant factor in predicting skill competency. Specifically, older students had higher average scores in practising mechanical ventilator skills. This indicates that incorporating VR technology can be especially advantageous in meeting

the varied learning requirements of students in various age brackets, promoting a more comprehensive and efficient educational setting.

These findings emphasize the potential of VR as a powerful tool in nursing education. VR provides immersive and engaging experiences that improve learning outcomes. Nevertheless, to effectively capitalize on the advantages of VR technology, it is imperative to acknowledge and rectify the recognized constraints and enhance the execution tactics. Future research should prioritize conducting studies over extended periods, fostering cooperation amongst multiple institutions, and using more objective assessment methodologies to authenticate and build upon these findings. By utilizing virtual reality, educational institutions can enhance the preparation of nursing students for the intricate challenges of clinical practice, hence enhancing patient care and increasing results within the healthcare system.

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Appendices

Appendix (1)

The ethical approval to start the study from IRB

Arab American University- Palestine
Deanship of Scientific Research
IRB committee
Tel: 04-241-8888, ext 1196
E-mail: irb.aaup@aaup.edu

الجامعة العربية الامريكية- فلسطين
عمادة البحث العلمي
لجنة أخلاقيات البحث العلمي
تلفون: 1196 ext 04-241-8888
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IRB Approval Letter

Study Title: The Effect of Mechanical Ventilator Educational Program Via Virtual Reality on Knowledge and Skills Among Nursing Student in AAUP.

Submitted by: Mohammad Daoud Abu Thehair

Date received: 15th April 2023

Date reviewed: 12th May 2023

Date approved: 12th May 2023

Your Study titled "**The Effect of Mechanical Ventilator Educational Program Via Virtual Reality on Knowledge and Skills Among Nursing Student in AAUP**" With archived number 2023/A/85/N was reviewed by the Arab American University IRB committee and was approved on 12th May 2023.

Reham Khalaf-Nazzal, MD, PhD
IRB committee chairman
Arab American University of Palestine

General Conditions:

1. Valid for 4 months from date of approval.
2. It is important to inform the committee with any modification of the approved study protocol.
3. The committee appreciates a copy of the research when accomplished.

لجنة أخلاقيات البحث العلمي في الجامعة العربية الامريكية

IRB at Arab American University

Appendix (2)

2.Knowledge:

Read the following questions and put (□) mark under your answer:

No.	Question	True	false	I don't know
Knowledge about Mechanical ventilators:				
1.	A mechanical ventilator is indicated to maintain safe levels of oxygen or carbon dioxide.			
2.	(SIMV) is: Non-invasive respiratory support utilizing continuous distending pressure during inspiration and expiration in spontaneously breathing babies.			
3.	Minute volume (MV) is the volume of gas inspiration or expiration during a breath.			
4.	Tidal volume (VT) is the amount of gas that passes in or out of the patient's lungs during one minute.			
5.	Oxygen concentration (FiO2) is the fraction of inspired oxygen.			
6.	Expiratory time (TE) is: the set time designated for inspiration during a breath.			
7.	Inspiratory time (TI) is: the set interval of time designated for expiration during a breath.			
8.	Inspiratory - Expiratory (I:E) ratio is: the ratio of inspiratory time compared to expiratory time.			
Knowledge about Endotracheal Intubation				
1.	The endotracheal tube is a tube that is inserted at the mouth to permit mechanical ventilation and to facilitate secretion removal.			
2.	ET tube sizes 7.0 to 8.0 mm are used for females and 8.0 to 9.0 mm for males.			
3.	The optimal insertion depth of the endotracheal tube can be reliably estimated through the use of prediction equations based on patient height, and weight			
4.	Tube placement based on chest X-ray results.			
5.	ABG ensures adequacy of ventilation and oxygenation.			
Knowledge of mechanical ventilation settings based on Arterial Blood gases (Abgs):				
1.	Hyperventilating the patient (low PaCO2) causes cerebral vasoconstriction and helps lower ICP.			
2.	In respiratory acidosis we get decrease the Co2 by the increase of respiratory rate and PEEP.			
3.	In respiratory alkalosis we retain more co2 by lowering the respiratory rate.			
4.	PEEP used for decreased Fio2 needed.			
5.	When the blood gas results indicate acute respiratory alkalosis (hyperventilation) which is not the result of excessive tidal volume but because the patient is hypoxemic, the most appropriate choice to reverse the hypoxemia is to increase the PEEP level.			

Suctioning procedure:				
1.	The connecting tubing should be attached to the suction machine and turned on before applying sterile gloves.			
2.	For client safety and quality care, the nurse should Hyper oxygenate before and after suctioning.			
3.	Assess for the need of suctioning every 2-3 hours.			
4.	A nurse is required to dispose a suction catheter Immediately after one single use.			
5.	when caring a ventilated patient is required to wear gloves during Oral and ETT suctioning.			

□

3. Skills:

Read the following practice items and put (□) mark under the column of the options (Always - often - sometimes - rarely - never) you select according to what you do for each item.

Note: <u>Only one option is possible for each question</u>

No.	Items					
		Always	**Often**	**Sometimes**	**Rarely**	**Never**
1.	Explain the procedure to the patient's family.					
2.	Perform hand washing before and after any contact with patients on Mechanical Ventilator.					
3.	Wear personal protective equipment (gown, gloves etc.).					
4.	Elevate the head of the bed as needed to prevent aspiration.					
5.	Change position to patients on Mechanical Ventilator every three hours.					
6.	Continuously monitor oxygen saturation with pulse oximetry to ensure that changes in oxygen saturation will be quickly managed.					
7.	Assess frequent changes in respiratory status If change is noted, notify the attending physician.					
8.	Assess for the need of suctioning every 2-3 hours.					
9.	Assess lips and tongue for pressure ulcers and provide oral care.					
10	Rotate tube placement from side to side of the mouth.					
11	Document in the nurse's notes which provide legal record & communication to other members of the heath team.					

Appendix (3)

The Open Epi – Toolkit Shell for Developing New Application

Results from OpenEpi, Version 3, open source calculator--SSPropor Print from the browser with ctrl-P or select text to copy and paste to other programs.

https://www.openepi.com/SampleSize/SSPropor.htm

Start
Enter
Results
Examples
Help

Sample Size for Frequency in a Population

Population size(for finite population correction factor or fpc)(*N*):	550
Hypothesized % frequency of outcome factor in the population (*p*):	94.5%+/-5
Confidence limits as % of 100(absolute +/- %)(*d*):	5%
Design effect (for cluster surveys-*DEFF*):	1

Sample Size(*n*) for Various Confidence Levels

ConfidenceLevel(%)	Sample Size
95%	70
80%	33
90%	52
97%	84
99%	111
99.9%	160
99.99%	201

Appendix (4)

The picture of VR


Outline
Indications & criteria
Types of Mechanical ventilators
complications
Nursing Care
Alarms & Weaning


3/5
NIKE

الملخص

الخلفية: برزت تقنية الواقع الافتراضي (VR) كاستراتيجية مبتكرة لتعليم التمريض، حيث تقدم عمليات محاكاة غامرة وتفاعلية تحاكي تجارب المرضى الحقيقية في بيئة خاضعة للرقابة. تهدف هذه الدراسة إلى تقييم تأثير برنامج تعليمي خاص بجهاز التنفس الصناعي من خلال استراتيجية الواقع الافتراضي الغامر على معارف ومهارات طلاب التمريض في الجامعة العربية الأمريكية–فلسطين.

الطريقة: استخدمت الدراسة شبه التجريبية استبيانًا ذاتيًا للحصول على بيانات موضوعية وإحصائية حول معرفة ومهارات طلاب التمريض في الجامعة الأمريكية في مجال التهوية الميكانيكية. شملت 80 طالبًا من طلاب التمريض (40 مجموعة تدخلية و40 مجموعة ضابطة) تم اختيارهم من الطلاب الذين أخذوا دورة تدريبية مسبقًا (MEDICAL3)، التدخلية في مختبر المحاكاة، المجموعة الضابطة في المحاضرات في قاعات الجامعة في الفترة من 10 إلى 20 يونيو 2024.

النتائج: كان متوسط أعمار المشاركين في المجموعتين التداخلية والسيطرة 21.80 (±1.22) و21.74 (±1.12) على التوالي. في الاختبار البعدي، كان متوسط درجات المعرفة ذات دلالة إحصائية بين مجموعتي التدخل والمراقبة 4.66 (±0.95) و3.19 (±1.05)، على التوالي، فيما يتعلق بأجهزة التنفس الصناعي. المجموعتان التداخلية والضابطة في كافة مجالات المعرفة في الاختبار البعدي (قيمة p<0.05). وكانت جميع متوسطات الدرجات في المجموعة التداخلية أعلى من مستويات الدرجات المتوسطة مقارنة بالمجموعة الضابطة. وفي المقابل، لم تكن هناك دلالة إحصائية بين المجموعتين التداخلية والضابطة فيما يتعلق بمستوى المهارات في الاختبار البعدي (قيمة P = 0.35). وقد شوهد تغير ذو دلالة إحصائية بين معرفة المجموعة التدخلية قبل وبعد الاختبار بأجهزة التنفس الصناعي.

الاستنتاج: وجدت هذه الدراسة أن برامج تدريس الواقع الافتراضي تعمل على تحسين كفاءة طلاب التمريض في استخدام أجهزة التنفس الصناعي. أدى التدريب القائم على الواقع الافتراضي إلى تحسين مستوى الطلاب أكثر من التعلم التقليدي. توضح هذه النتائج أن الواقع

الافتراضي قد يعزز تعليم التمريض من خلال تقديم تجارب غامرة. يجب تعظيم فوائد الواقع الافتراضي من خلال معالجة حدوده وتحسين تكتيكات النشر.

الكلمات المفتاحية: مروحة ميكانيكية؛ البرنامج التعليمي; الواقع الافتراضي؛ معرفة؛ مهارات؛ طلاب التمريض؛ وفلسطين.