An Innovative Approach in Psychomotor Skill Teaching for Nurses: Virtual Reality Applications

Abstract

Psychomotor skill training is a process applied at laboratories for putting theoretical training into practice. In this training process, although students are trying to apply it on the model through following the demonstration and make students adopt this as a skill, gaining this skill may be deficient due to larger number of students and insufficient number of teachers. Therefore, technological hardware of today revealed availability of virtual reality applications that aim to make students gain experience as much as possible and whenever and wherever they want. Virtual reality is a part of simulation in nurse's education and comprises the hardware at utmost reality level. As much the similarity with real world increases, the motivation and gains from the skills can be at best level. Studies where usage of the virtual reality increase day by day, studies on this issue newly commenced in our country. Therefore, this composition explained that the virtual reality applications in trainings of students to develop their psychomotor skills are important, and the studies conducted in relation with subject have been submitted; and it has been intended to be guiding study about feasibility thereof in our country.

Keywords: Nurse training, Psychomotor skills, Virtual reality

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Introduction

Nursing is a combination of science and art. Nursing students are expected to put theory into practice, which is possible with psychomotor skill teaching.[1] Psychomotor skill is the activities that occur with the coordinated work of the mind and muscles in order to achieve a targeted task consciously.[2] Teaching psychomotor skills consist of three stages: First, academics demonstrate the necessary skills; second, they get students to put those skills into practice, and third, they give them feedback until they get them right.[3]

Laboratory (lab) settings should be similar to real-life hospital settings to encourage students to put psychomotor skills into practice.[4] Students prefer to use technology in realistic settings and think that interactive learning methods are necessary.[5] Advances in technology allow us to create high-reality labs to motivate the new generation of students. For example, life-like mannequins that react like real humans can be used in labs.[6] In fact, this technology can be transferred to the virtual environment to create high-reality simulation settings. Virtual environments provide flexibility to students. In other words, they allow them to watch and interact with Virtual Reality (VR) whenever and wherever they want.[4,7–9] Those environments that require advanced technology are in the form of image-based, high-fidelity, and interventional high-tech interactive patient simulators and VR and haptic systems.[10] This review explained the significance of VR-based psychomotor skill training in nursing education, discussed relevant studies, and provided guidance on the feasibility of that technology in Turkey.

What is Virtual Reality?

The word "virtuality" is derived from the Latin word "*virtualis*." According to the Turkish Language Association, the word "virtual" means conceived, fictitious, hypothetical, or suppositional," while the word "reality" means "the thing that is real or all things that exist." Real situations designed in virtual environments correspond to VR, consisting of the combination of two concepts: virtual and reality.[11] According to Kayabasi, VR is an interactive computer-based technology that promotes human-machine interaction, appeals to all senses, and facilitates learning.[12]

History of Virtual Reality

Ray Bradbury was the creator of the concept of "virtual reality" because he was the first to talk about it in his extraordinary short story "The Veldt" in 1950. Virtual reality underwent significant progress towards the end of the Second World War, and Morton Heilig invented the first virtual reality simulator in 1962. He called the simulator "Sensorama," which allowed the user to view 3D colored images accompanied by stereo sound, smell, and wind effect.[13] Virtual reality was first used in the 1980s by the National Aeronautics and Space Administration (NASA) to repair, maintain, or assemble spacecraft remotely.[14] Later, the technology became widely available in video games and entertainment, education, culture and art, and tourism, e-commerce, manufacturing, military, airline, and construction industries.[15] Virtual reality became so popular that it was also incorporated into the field of vocational education and training. It was first used to train soldiers,

astronauts, and pilots.[12,16,17] Nehring and Lashley[18] mentioned thatthe first to use virtual reality in nursing, the first to develop an intravenous (IV) catheter insertion model, and the first to use Internet-interactive virtual environments in nursing.

Virtual reality is used in IV and urinary catheterization, drug infusion and management, port catheter injection, cardiopulmonary resuscitation, chronic obstructive pulmonary disease management, fundamental skills, and aseptic technique and decontamination.[19–28] Virtual reality is used to help Turkish nurses develop skills (tracheostomy care and IV catheter application).[29,30]

Virtual Reality Applications

Virtual reality applications are computer-aided design systems that simulate real-world environments where users can interact simultaneously through graphical interfaces called "avatars."[31] Avatars are representations of users in software form who can move in three dimensions utilizing hardware, such as keyboard and mouse.[12] "Nurses" in nursing training are "avatars." Users can give instructions to those avatar nurses to perform interventions defined by the software. The earliest example of VR technology in nursing is the CathSim Intravenous Training System (CathSim ITS) in 1998. Research shows that the CathSim ITS improves nursing students' performance, reduces the number of interventions, and helps them with anxiety, pain, and hematoma.[24,32,33] Some researchers in Turkey have used IV virtual simulators involving VR and haptic systems.[19,30,34] These studies show that simulators help students develop skills. Virtual reality haptic systems replace hardware (mouse or keyboard) and allow human touch and interaction with VR settings.[17]

Types of Virtual Reality

There are two types of VR depending on the level of interaction and three-dimensionality: immersive and non-immersive. The term "immersive" means "surrounding, enveloping, encompassing, or generating a three-dimensional image".[17] In immersive VR, the user wears a headset or glasses that project computer-generated images onto their field of vision. This type of VR makes the user (student) feel like they are in a patient room while actually standing in an empty room. The student may also wear haptic gloves and use virtual equipment to perform interventions on the virtual patient,[35] which is an interactive computer simulation that communicates and presents with symptoms like an actual patient.[31] A target skill is integrated into a patient scenario, which is then transferred to the virtual environment. The student wears the headset or glasses and haptic gloves and plays out the scenario by touching virtual objects and performing intervention steps. Immersive VR appeals to all senses, facilitating learning and resulting in learning retention.[16]

Non-immersive VR provides three-dimensional computer-based environments which the student can control via a keyboard, mouse, joystick, and haptic screen.[35] In non-immersive VR, the student gets into the application on their computer, tablet, or mobile phone and uses the keyboard or mouse to execute the intervention steps. Non-immersive VR is more commonly used and studied[20,21,25,26,28,36–38] than its immersive counterpart because it is more affordable. Virtual reality, immersive or non-immersive, generally uses virtual patients. Sometimes haptic systems are incorporated, and sometimes the simulation environment is gamified.[39]

Virtual Reality Applications in Psychomotor Skills Teaching

Virtual reality becomes increasingly popular in helping nursing students develop psychomotor skills because it allows them to put theory into practice and makes them feel like they are in real-life three-dimensional clinical settings.[39] Virtual reality environments allow them to interact with virtual patients and conduct interventions using virtual equipment. Students can also receive feedback on what they did right or wrong,[29,39] allowing them to perform dangerous and costly interventions as often as they wish without risking patient safety.[17] Virtual reality environments also provide them with the opportunity to perform the interventions they have performed on mannequins in labs but have not yet performed in clinical settings.[29,37] For example, they can administer tracheostomy care or urinary catheterization on virtual patients.[19,29] In this way, they can gain mastery over those skills without harming any patient. Besides, students who perform interventions on virtual patients are likely to experience less anxiety and feel more confident when they perform those interventions on real patients for the first time after lab practice.[39] Some studies incorporate games into VR environments.[20,23,29,40–42] Those types of games are called "serious games," which are either immersive or non-immersive. Most studies focus on the feasibility of non-immersive serious games.[22,28,42] Table 1 presents the studies that employed VR technology.[20,21,23,25,26,28–30,36–38,40–43]

Biyik Bayram and Çalışkan[29] developed a scenario which focused on the steps of tracheostomy care, target behavior, and instructions concerning the process steps. The virtual environment in the scenario consists of a patient and her room and a nurse and a treatment room. The student progresses as she performs the steps correctly and cannot move onto the next step if she fails to accomplish one. Unlike games in other studies, nursing students installed the game on their mobile phones and performed the tasks over and over again.[29]

Methods and Disadvantages of Studies on Virtual Reality

The methods follow four steps: First, goals are identified in accordance with the steps of the process. Second, goals are integrated into a scenario, which is then transferred to a virtual environment. Third, the student is expected to perform the intervention using tools (mouse, haptic screen, haptic gloves, etc.). Fourth, the student takes a test if she accomplishes the skill steps. Virtual reality applications are usually held after theoretical, demonstration, and laboratory practice or with students who have learned the application before.[19,22,23] This is because students need to know the subject and process steps to be able to execute the target skills and reach the goals. For example, if the student does not know how to use the equipment, she cannot give the right instructions to the system and cannot proceed. Therefore, VR applications should be used after lab practice so that students can go over subjects and put theory into practice.

Virtual reality applications have some disadvantages. First, they are expensive applications that require long-term practice and the involvement of multiple units. Second, they require technical knowledge and collaboration with experts in computer technology to adapt them to nursing. Third, it takes a long time to train people who will use them because they contain novel technological equipment.[17] Fourth, prolonged use can cause dizziness, headache, or eye pain.[44] Research shows that VR applications are limited because they require lengthy preparation and allow students to go over topics they already know about.

Table 1. Studies on Virtual Reality Applications

Author/Year	Participants	Design	Method	Measurement Method	Virtual Reality Type	Psychomotor Skill	Outcomes
Bıyık Bayram and Çalişkan[29] 2019	86 nursing students (43 control and 43 experimental)	Randomized controlled study	The control group students worked on models in the laboratory, while the students in the experimental group worked on their mobile phones with a virtual reality game	23 questions knowledge test and objective structured clinical exam	Non-immersive mobile VR game	Tracheostomy care skills	It was stated that the knowledge and skill levels of the students who used the VR game increased
Butt et al.[19] 2018	20 nursing students	Pilot study	The students of control group practiced using the traditional method and the students of experimental group applied in a VR environment with a device and gloves they wore on their heads	4-point Likert type scale with 10 questions	İmmersive touch VR game	Urinary catheterization skills	Students working with this application stated that the application was very interesting and fun and their level of knowledge increased
Kardong-Edgren et al.[43] 2018	31 nursing students	Pilot study	Students applied urinary catheter to the virtual patient with the head and hand attachments	4-point Likert type scale with 10 questions and 26 questions in electronic environment	İmmersive touch virtual reality game	Urinary catheterization skills	It is stated that the game is fun and effective in teaching
Günay İsmailoğlu and Zaybak[30] 2018	65 nursing students	Randomized controlled quasi-experimental study	The control group worked with the plastic arm model and the experimental group worked with the VR application	15 question knowledge test, checklist consisting of 20 processing steps, self-confidence visual scale and fear symptoms scale	Non-immersive computer-based VR	Intravenous catheterization skills	It has been stated that it increases students'skills and self-confidence and decreases their fears
Gu et al.[40] 2017	28 nursing students	Randomized controlled study	After the subject was taught, the experimental group also worked with the VR application	Knowledge test and skill checklist	Non-immersive computer-based VR game	Asepsis, urinary catheterization, and drug management	It was stated that the knowledge and skills of the students increased
Smith et al.[20] 2016	108 nursing students	Randomized controlled quasi-experimental study	The control group worked with the web study, while the experimental group worked with the virtual simulation application in addition to the web study	Rubric scale including 20-question knowledge test and 17 statements	Non-immersive computer-based VR	Dekontamination	It was stated that the knowledge and skills of the students increased and the knowledge was permanent
Smith and Hamilton[21] 2015	20 nursing students	Experimental study	The control group worked in the laboratory and the experimental group worked in a computer-based VR environment	Visual scale	Non-immersive computer-based VR	Urinary catheterization skills	It has been stated that the application skills have increased

Table 1. Studies on Virtual Reality Applications (Continued)

Author/Year	Participants	Design	Method	Measurement Method	Virtual Reality Type	Psychomotor Skill	Outcomes
Boada et al.[22] 2015	109 nursing students	Randomized controlled study	The students played the virtual reality game named "LISSA" over the computer for seven days	Checklist containing 15 steps determined for cardiopulmonary resuscitation and a 5-point Likert-type scale evaluating the use of "LISSA"	Non-immersive computer-based VR	Cardiopulmonary resuscitation	It has been determined that the game increases student skills and motivation
Tsai et al.[23] 2015	68 nursing students	Randomized controlled, pre-test and post-test study	A computer game was prepared and the students played the game on the computer	5 propositions and 3 open-ended questions in computer environment	Non-immersive computer-based VR game	Caring for chronic obstructive pulmonary disease	It was found that the skills of the students who played the virtual reality game increased and their anxiety decreased
Chia[41] 2013	151 nursing students	Qualitative study	The students played the game in computer environment for seven days and evaluated themselves	7-question 4-point likert scale	Non-immersive computer-based VR game	Caring for chronic obstructive pulmonary disease	The students stated that their knowledge on this subject increased and the game was interesting
Buttussi et al.[42] 2013	39 nursing students	Pilot study	The students played the virtual game called "Emsave"	38-question test and 12 questions in 5-likert type for the use of the game	Non-immersive computer-based VR game	Cardiopulmonary resuscitation	As a result of the research, it was stated that the knowledge and skills of the students increased
Luctkar-Flude et al.[25] 2012	43 nursing students	Experimental stuy	The control group worked in the laboratory and the experimental group worked with the virtual learning module	A 5-point Likert-type scale with 10 and 11 questions and a 35-item skill checklist	Non-immersive computer-based VR	Intravenous drug infusion	It was stated that the students' self-confidence increased
Mosalanejad et al.[26] 2012	86 nursing students	Quasi-experimental study	The control group worked in the laboratory, while the experimental group worked with video and virtual animations	Skill assessments objective structured clinical exam	Non-immersive computer-based VR	Fundamentals of nursing skills	It was stated that skill scores increased
Farra et al.[36] 2015	106 nursing students	Quasi-experimental study	Experimental group students worked with VR application	Skill checklist with 17 processing steps	Non-immersive computer-based VR	Dekontamination	It was stated that the decontamination skills of the students increased
Tsai et al.[37] 2008	77 registered nurses	Pre-test and post-test study	The control group worked with traditional methods and the experimental group worked with the virtual reality application	Knowledge test	Non-immersive computer-based VR	Port catheter injection	It has been stated that the knowledge and skill levels of nurses have increased

Table 1. Studies on Virtual Reality Applications (Continued)							
Author/Year	Participants	Design	Method	Measurement Method	Virtual Reality Type	Psychomotor Skill	Outcomes
Tsai et al.[38] 2008	10 students	Pilot study	Participants worked with the VR application	Knowledge test, error frequency and time were observed	Non-immersive computer-based VR	Intravenous catheterization skills	It was reported that the intravenous catheter application of the participants had a decrease in the frequency of errors and the duration of the procedure
Engum et al.[28] 2003	93 medical and 70 nursing students	Randomized controlled study	The experimental group students worked on the VR application, while the control group students worked on the arm model. Pre-test and post-test were applied	20-question test, 21-step skill checklist	Non-immersive computer-based VR	Intravenous catheterization skills	It has been stated that there is an increase in the knowledge scores of the students who use the VR method

Conclusion

All in all, virtual reality environments help students develop psychomotor skills, motivation, and self-confidence, increase learning retention, and reduce anxiety. Virtual reality environments provide students with the opportunity to practice whenever and wherever they want and encourage them to develop skills outside the lab. These practices support formal education and agree well with the learning styles of the new generation students. Technology today is an indispensable part of our lives. Therefore, it is recommended that nursing schools use VR applications. Although they are popular in the literature, they are not very common in Turkey. There are no virtual reality simulation studies in Turkey because it is an expensive technology that requires technical equipment and lengthy preparation. Given their contribution to psychomotor skills, we recommend that educational institutions in Turkey plan such applications and that researchers conduct studies to determine their contribution to teaching.

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