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Virtual Simulation in Clinical Nursing Education to Improve Knowledge and Clinical Skills: Literature Review

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Abstract

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BACKGROUND: Nursing as a professional education must have a solid professional foundation to encourage nursing professionals' attitude, behavior, and ability to carry out the nursing practice.

AIM: This study aims to review the effectiveness of virtual simulations (vSIMs) in clinical nursing education in increasing the clinical knowledge and skills of new nurses and nursing students.

METHODS: A literature review using the PRISMA method from the online database Science Direct, Scopus, and PubMed with the keywords vSIM, clinical nursing education, knowledge, and nursing skills from 2016 to 2020.

RESULTS: It was found that 162 articles were found. Then, 25 articles can be reviewed based on inclusion and exclusion criteria. The reviewed articles used a quasi-experimental design. While articles in the form of pilot projects, literature/systematic reviews, qualitative, and descriptive studies were excluded from the study. Based on the review of articles, it was found that, on average, they discussed the effectiveness of vSIMs used in the clinical learning process in hospitals. It can be applied to new nurses and nursing students.

CONCLUSION: Virtual simulation is useful for learning new skills; practicing skills that combine content, critical thinking, and psychomotor elements; learning skills competencies, and the ability to make decisions. In the era of the Coronavirus Disease 2019 pandemic, vSIM is a safe and realistic nursing education technology for nurses and nursing students.

Introduction

The coronavirus disease 2019 (COVID-19) pandemic impacts various spheres of life, one of which is education. Schools or campuses are one of the public facilities that have a direct impact because schools are one of the community locations for activities that have the potential to become a locus for the spread of COVID-19. Pandemic conditions force people to adopt new habits to a productive and safe society against COVID-19. This requires structuring the implementation of various activities with public health priorities, including providing education [1]. The nurses and nursing students from 20 countries who had completed the E-simulation program experienced a significant increase in knowledge and performance. E-simulation can improve student preparation for practice and improve the quality of nurse management for deteriorating patients [2].

The impact of the spread of COVID-19 has occurred in certain circumstances, so it is necessary to make countermeasures, one of which is the Large-Scale Social Restriction. One of the Large-Scale

Social Restrictions actions is school holidays [3]. With this policy, the face-to-face learning method has been temporarily stopped and replaced with the online learning method. Most clinical practice fields also prohibit students from directly practicing clinical practice. Technological developments in the availability of software, hardware, and internet networks open up opportunities for innovation, including nursing education. The online learning method has increased since the government established the Large-Scale Social Restriction policy [4].

Learning online (in the network)/online/distance learning aims to meet educational standards using information technology (IT) using a computer device or gadget. Students and lecturers are connected by not making physical contact. The hope is that the teaching and learning process can continue to be carried out correctly through this technology. The use of information technology is expected to overcome the obstacles in the teaching and learning process during the COVID-19 virus epidemic. This is possible because the majority of Indonesians are currently using the Internet [5].

The COVID-19 pandemic forces the world of education to make changes in the achievement

of competence in the learning system, both theory, laboratory, and clinic. Simulation practice is one of the effective teaching and learning strategies. One of the learning methods that can be a solution is Virtual Reality Simulation (VRS). The results showed that the practicum learning method using VRS increased student motivation in achieving laboratory practicum competencies during the COVID-19 pandemic. There were 73.3% of students who expressed positive reactions and felt enthusiastic after trying practicum using VRS [6].

A study about fundamentals of nursing that providing content in the basic practical skills, knowledge, communication strategies, and beginning pharmacology is the first course in which students learn how to perform nursing skills to patients showed that students in the experimental group had significantly higher knowledge scores than students in the control group. The results in this study indicate that virtual simulations (vSIMs) for nursing are an effective additional teaching strategy to increase students' knowledge about the basics of nursing [7].

Dubovi [8] explained that the achievement of students who learn using computer-based multimedia visualization is superior to students who only learn based on video and animation. This study proposes that visualization plays an important role in the effectiveness of learning in a computer-based multimedia environment. The learning simulation used is computer-based online, designed to use three alternative multimedia simulations of video, animation, and agent-based visualization through learning clinical skills [8].

Student's perceptions of clinical assessment abilities increased after receiving clinical learning through vSIMs. The findings suggest that vSIMs benefit students' learning and development in clinical skills [9]. Nursing as a profession education must have a solid professional foundation to foster the attitude, behavior, and ability of nursing professionals to carry out the nursing practice. In the era of the COVID-19 pandemic, vSIM is a safe and realistic nursing education technology for nurses and nursing students. Virtual simulation is useful for learning new skills; practicing skills that combine content, critical thinking, and psychomotor elements; learning skills competencies, and the ability to make decisions. This paper aims to determine the effectiveness of vSIMs in clinical nursing education through a literature review.

Methods

The writing method used is a comprehensive summary in the form of a literature review on the

effectiveness of vSIM in clinical nursing education. The literature search was carried out in January–February 2021. The data source came from reputable international journals from the online database, namely, Science Direct, Scopus, and PubMed, in the 2016–2020. Researchers obtained 162 articles using keywords that have been adjusted to MeSH consisting of three articles from PubMed, 24 articles from Scopus, and 135 articles from Science Direct. Protocol and evaluation of the literature review using the PRISMA checklist instrument to determine the finalization of the study and refer to the objectives of the literature review [10] (Table 1).

Data analysis

Researchers obtained 162 articles using keywords that have been adjusted to MeSH consisting of three articles from PubMed, 24 articles from Scopus, and 135 articles from Science Direct. From the search results, it was found that 22 of the same articles were excluded, and there were only 140 articles left. The researcher screened the full-text articles ($n = 140$), the research design/method ($n = 72$), and the research results ($n = 25$), which were adjusted to the theme of the literature review. The assessment was carried out based on the inclusion and exclusion criteria eligibility and obtained 25 articles that could be used in the literature review (Table 2). The results of the study article selection are illustrated in flow diagram:

Results

Characteristic of study

Twenty-five articles meeting the inclusion criteria (Figure 1) were divided into two sub-discussions based on the topic of literature review, namely, knowledge on clinical skills (nine studies) and clinical skills (11 studies) and five studies of them. The contributing factors in this are mostly quasi-experimental and cross-sectional. Participants were students, graduates, and nurses with an average of more than 10,000. Overall, each study addresses clinical knowledge and skills. Studies that are following a systematic review that is about learning have been conducted in nine countries, including Hong Kong [11], [12], the USA [13], [14], China [15], Turkey [16], Malta [17], Portugal [18], [19], and Canada [20], [21], [22]. A systematic review of clinical skills contained 11 studies conducted in various countries, including Turkey [23], Australia [2], the USA [9], [24], [25], [26], India [27], Korea [28], [29], Singapore [30], and Canada [31]. While a systematic review discusses the two topics, there are five studies that there are Finland [32], Israel [8], Korea [33], [34], and Australia [35].

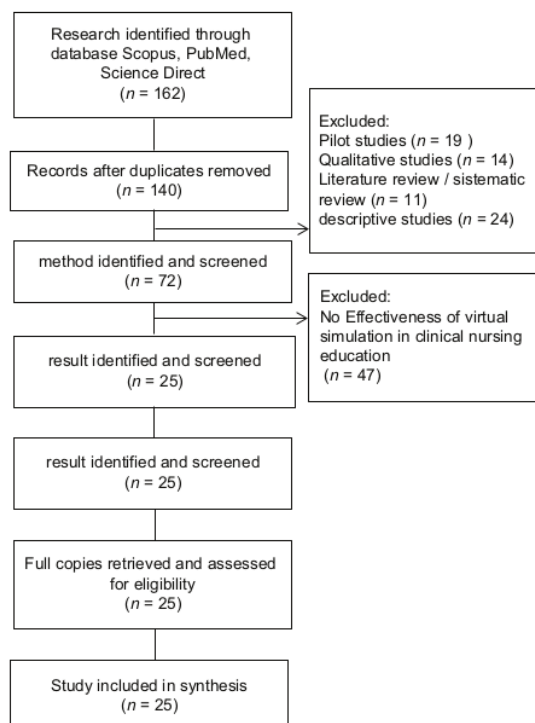


Figure 1: Literature review flow diagram based on preferred reporting items for systematic reviews and meta-analyses 2020 [10]

Unexpected end of formula characteristic of respondent

Respondents in the study were nursing students, nursing graduates, and nurses in their respective countries. The study discussed clinical knowledge and skills of nursing, with the majority of respondents numbering more than 10,000. Respondents in the study had an average productive age between 18 and 40 years and were multi-regional. Gender characteristics of respondents are almost the same between men and women because the study is comprehensive, and the most of the minimum education level is diploma level.

Discussion

Knowledge

Virtual simulations effectively increase students' knowledge of clinical nursing education. The study results show that students in the experimental group had much higher knowledge scores than students in the control group after using (vSIM). Participants in the intervention group had significantly higher scores of knowledge, self-confidence, and health assessment skills [30]. The results showed a significant increase

Table 1: Keywords literature review

vSIM	Clinical nursing skill	Nursing education
vSIM	Clinical nursing skill	Nursing education
Or	Or	Or
Clinical simulation in nursing	Nursing clinical education	Nursing education today
	Or	Or
	Clinical nursing skill	Nursing education in practice

vSIM: Virtual simulation.

in students' post-scenario knowledge with vSIMs [17]. This suggests that vSIM for nursing may be an effective additional teaching strategy for increasing student knowledge in the basics of nursing.

Learning with a combined method, computer-based exploration and visualization will be more profitable and more than just video-based visualization and animation. Visualization plays an important role in the effectiveness of learning with an adequate computer-based multimedia environment [8]. The post-test knowledge score was higher than the pre-test knowledge score for the two groups after being given material with a virtual simulator rather than the method used in the form of video training [16]. The computer-based visualization learning method provides more opportunities for students to explore the material displayed [30]. Students will easily choose and do trials using a computer device instead of watching videos or animations[42]. Video and animation media only provide information in one direction. The results showed a significant difference in student learning, that students better understand the importance of learning topics and feel satisfied and motivated by the technology and methods applied [8]. Using persuasive technologies such as small mobile devices as mediators of online education interventions expand learning spaces in an innovative, flexible, motivating, and promising manner [40]. Learning models that utilize information and communication technology facilities can be carried out by distance learning. This method is carried out using information technology using electronic devices, namely, laptops, computers, and gadgets with the use of internet media, E-Learning, Google class, WhatsApp media as a means of communication, and zoom and zoom, and YouTube applications [5].

Clinical vSIMs also provide knowledge retention and baseline clinical reasoning over time (2 months) and increase student satisfaction with learning without affecting general efficiency perceptions. Virtual clinical simulations allow a 20.4% increase in knowledge retention and students' clinical reasoning in a learning context (18). The results showed that almost all (96.2%) participants stated that new nurses needed simulation training. The highest-ranking category is fundamental nursing knowledge, followed by nursing technique fundamentals. Among the 81 nursing education need items, the top-ranking things were cardiopulmonary resuscitation, artificial airway care, oxygen therapy, and mechanical ventilation, most of which were in the technique-base-nursing category. Educational needs differ significantly depending on participants' clinical experience, type of hospital, and experience as mentors.

Table 2: Literature search results

Authors and years	Study design, sample, variable, instrument, and analysis	The outcome of analysis factors	Summary of result
[12]	<p>Study design: Quasi-experiment</p> <p>Sample: 11 undergraduate nursing students</p> <p>Variable: HFPS in teaching clinical reasoning skills to undergraduate nursing students and a comparison with other teaching methods</p> <p>Instrument: The experimental grub was given HFPS treatment, and the controlling grub was given another treatment</p> <p>Analysis: Independent t-test</p>	The effectiveness of using HFPS on knowledge acquisition examined skill performance and critical thinking	The HFPS is more effective than other teaching methods in teaching clinical reasoning skills to undergraduate nursing students. The results indicated a lack of statistically significant difference in the learning outcomes from HFPS versus traditional modalities and low-fidelity simulation
[32]	<p>Study design: Cross-sectional and descriptive study</p> <p>Sample: Nursing students from the surgical nursing course of autumn 2014 (n = 166).</p> <p>Variable: Prototype of the simulation game used in this study was single-player in format</p> <p>Instrument: Online questionnaire</p> <p>Analysis: Cross tabulation and Chi-square test</p>	Clinical reasoning process, how to take action and collect information, evaluate the effectiveness of interventions, and apply theoretical knowledge	The results show that those who played digital games daily or occasionally felt that they learned clinical reasoning by playing the game more than those who did not. Nursing student's experiences of learning the clinical reasoning process by playing a 3D simulation game showed that such games could be used successfully for learning
[23]	<p>Study design: A single-blind, randomized, and controlled trial conducted</p> <p>Sample: A total of 86 1st-year nursing students registered in</p> <p>Variable: The based virtual reality phone application is used as a simulation to teach psychomotor skills</p> <p>Instrument: The data were collected with an informative features form</p> <p>Analysis: One-sample Kolmogorov–Smirnov test, Mann–Whitney U-test, and Wilcoxon test</p>	A tracheostomy care knowledge test, skill checklists, and a performance assessment form	This study determined that the suctioning a tracheostomy tube and peristomal skin care average final test scores of the students in the experiment group were higher than the students' average scores in the control group; this was statistically significant (p = 0.017, P = 0.003)
[36]	<p>Study design: Using a mixed-methods approach</p> <p>Sample: Six Bachelor of Science in Nursing students participated in a 4-week-based</p> <p>Variable: A vSIM to teach nursing students concepts of triage using the sort, assess, lifesaving interventions, and treatment/tri-port model</p> <p>Instrument: Students took a 20-item, multiple-choice test before and after the simulation and participated in a debriefing session</p> <p>Analysis: A Wilcoxon signed-rank test</p>	<p>4</p> <p>Qualitative data revealed the following themes: (a) Fun, (b) Appreciation for immediate feedback, (c) Better than reading, and (d) Technical issues</p>	<p>4</p> <p>No statistically significant improvement on the post-test (p⁴ = 0.168). vSIM may be a teaching solution with the advancement in technology and further educational research efforts</p>
[7]	<p>Study design: Quasi-experimental</p> <p>Sample: 28 students in a central city in China</p> <p>Variable: Effectiveness of SVM for nursing as a supplemental teaching strategy on performance of undergraduate students in a fundamentals of nursing course</p> <p>Instrument: Observation, checklist</p> <p>Analysis: Descriptive with IBM SPSS</p>	Nursing students' knowledge when used as an enhancement within fundamentals of nursing	Students in the experimental group had significantly higher knowledge scores than students in the control group. This study indicates that the vSIM for nursing might be an effective supplementary teaching strategy to improve students' knowledge of fundamentals of nursing
[2]	<p>Study design: Quasi-experimental</p> <p>Sample: All participants who had completed the version 1-B program for 28 months between September 2013 and January 2018</p> <p>Variable: E-simulation may enable a feasible education solution to the management of deteriorating patients</p> <p>Instrument: Scenario</p> <p>Analysis: Regression analysis</p>	Students' preparation for practice and improve qualified nurses' management of deteriorating patients	Qualified nurses (n ⁴ = 1229) and final year nursing students (n ⁴ = 1742) were among 5511 participants from 20 countries who completed the program. With no difference, both groups' knowledge and performance improved significantly (p ⁴ = <0.001). Revealed predictors of performance were education level, knowledge, experience, and being female. E-simulation may enhance students' preparation for practice and improve qualified nurses' management of deteriorating patients
[8]	<p>Study design: Cross-sectional</p> <p>Sample: Undergraduate nursing students (n = 97)</p> <p>Variable: Simulation virtual</p> <p>Instrument: Video, animation, and agent-based visualizations on learning of clinical reasoning skill</p> <p>Analysis: Independent t-test</p>	Learning of clinical reasoning skills	Learning gains were significantly higher for simulations that incorporated exploration of agent-based visualizations than for video- and animation-based visualizations. Interestingly, low achievers made significantly higher learning gains after learning with agent-based simulation than high academic achievers
[9]	<p>Study design: Cross-sectional</p> <p>Sample: Nursing students in child health in baccalaureate nursing degree program. (n = 234)</p> <p>Variable: vSIM</p> <p>Instrument: Lasater Clinical Judgment Rubric</p> <p>Analysis: Paired t-test</p>	Attempts and student self-perception of their clinical judgment abilities	Study results show statistically significant findings in attempts and student self-perception of their clinical judgment abilities. Findings suggest that vSIM is beneficial to student learning and the development of clinical judgment skills
[27]	<p>Study design: Quasi-experimental pre-test and post-test design</p> <p>Sample: 82 nurse-midwives of Indian</p> <p>Variable: Implemented a blended training model to supplement conventional classroom teaching with virtual training</p> <p>Instrument: Observations</p> <p>Analysis: Independent t-test</p>	Midwifery skills	A passing score was set at achieving 75% or higher. The students exposed to blended learning scored 32.57 points (p = <0.001) more than their counterparts, who received only conventional teaching. In the post-intervention cohort, 55% of students (n = 28) passed compared to none in the pre-intervention cohort. We found blended learning approach effectively improved access to quality training and identified critical midwifery skills of auxiliary nurse midwife students from remote locations
[16]	<p>Study design: Quasi-experimental pre-test and post-test design</p> <p>Sample: A total of 60 students</p> <p>Variable: Virtual simulator and video-assisted teaching on the level of intravenous catheterization skills and self-confidence of nursing students</p> <p>Instrument: Virtual simulator and video-assisted teaching on the level of intravenous</p> <p>Analysis: Mann–Whitney U-test</p>	Knowledge and psychomotor skills of intravenous catheterization skills, self-confidence	Post-test knowledge scores were higher than pre-test knowledge scores for both groups. There were no significant differences between the groups in terms of post-test scores. Student's scores of psychomotor skills were found to be higher in the virtual simulator group self-confidence scores were similar in both groups. Teaching with the virtual simulator contributed to the student's skills more than the method used in the video training. Both methods are effective in the development of knowledge and self-confidence related to intravenous catheterization

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Table 2: (Continued)

Authors and years	Study design, sample, variable, instrument, and analysis	The outcome of analysis factors	Summary of result
[24]	Study design: Mixed-method Sample: Eighty-two senior undergraduate nursing students Variable: Undergraduate nursing student perceptions and experiences, a computer-based simulation program as preparation before their simulated laboratory experience Instrument: Simulation video Analysis: Description	Improved prioritization, role-modeled nursing care, individualized preparedness, engaged critical thinking, decreased level of anxiety, and increased confidence in the laboratory	Preparatory computer-based simulation programs improved simulation lab experiences by encouraging individualization of student learning and were found to be an effective marker to enhance student learning
[14]	Study design: Quasi-experimental design Sample: A total of 165 baccalaureate nursing students Variable: Simulation in nursing education has demonstrated the positive impact active, and experiential learning has on student satisfaction, self-confidence, and knowledge Instrument: Video simulated Analysis: Data analysis used descriptive statistics and t-tests	Student satisfaction, self-confidence, and knowledge	There were no statistically significant differences, with both groups reporting a high level of satisfaction and self confidence The use of video simulation to augment classroom teaching is suggested as a strategy for engaging learners
[37]	Study design: Quasi-experimental design pre-post design Sample: The participants were 34 graduating nursing students. Variable: Simulation-based education program for nursing students responding to MCI from the perspectives of triage accuracy, responsible attitude, teamwork, and program satisfaction Instrument: Simulation-Emergo train system Analysis: T-test	Triage accuracy, responsible attitude, teamwork, and program satisfaction	There was a significant increase in positive attitudes after the intervention ($p < 0.001$). Self-reported teamwork was high, and leadership and team coordination scored the highest among its subfactors. Participant's satisfaction with the program was high (4.5/5.0) The simulation-based MCI program was effective in boosting positive attitudes among nursing students
[38]	Study design: Mixed-method, randomized controlled design Sample: 131 nursing students Variable: A computer simulation-based, interactive ComEd program and AC Instrument: A tablet PC or a desktop computer Analysis: Qualitative	Communication knowledge, learning self-efficacy, and communication efficacy	The AC and ComEd groups significantly improved communication knowledge, learning self-efficacy, and communication efficacy; these effects were maintained at 2 weeks. The participants well accepted the ComEd program. The ComEd is a promising approach because it is highly accessible, consistent, and repeatable and has positive learning effects
[39]	Study design: A single-center, single-blind, parallel randomized controlled trial Sample: Year one undergraduate nursing students enrolled in the CHA module during semester two of the academic year 2018/2019 Variable: SHAE program, Instrument: Video Analysis: ANCOVA	Student's knowledge, health assessment skills, and confidence	Participants in the intervention group had significantly higher scores on knowledge ($p = 0.016$), confidence ($p = 0.03$), and health assessment skills ($p = 0.004$). No significant differences in intention to learn and empathy between the two groups were found. The use of a case-based video has the potential to be a valuable method of teaching health assessments in context to nursing students
[31]	Study design: Quasi-experimental pre-post study Sample: Participants were randomly assigned to a treatment or a control group ($n = 59$) Variable: The hybrid simulation intervention Instrument: Observations of simulation intervention (adult and pediatric case) Analysis: Independent t-test	Clinical self-efficacy, confidence, and competence in the recognition and response to deteriorating patients	This study showed a high internal consistency (0.91). Significant improvement in all items on the clinical self-efficacy tool was seen in the treatment group after the intervention. On the contrary, there was no significant improvement in any of the clinical self-efficacy items in the control group. The hybrid simulation intervention proved effective in improving confidence and competence in recognizing and responding to deteriorating patients
[29]	Study design: Quasi-experimental design Sample: Total 81 participants, with 41 students in the control group and 40 students in the experimental group Variable: Investigate the impact of an SBAR communication program on communication performance, perception, and practicum-related outcomes in senior-year nursing students Instrument: SBAR checklist Analysis: Chi-squared dan independent t-test	Communication, communication clarity, and perceived handover confidence	Experimental group demonstrated significantly higher SBAR communication ($p < 0.001$), communication clarity ($p < 0.001$), and handover confidence ($p < 0.001$) than the control group. SBAR program in a pediatric nursing practicum improves SBAR communication, communication clarity, and perceived handover confidence in senior-year nursing students
[40]	Study design: This is a quasi-experimental, non-equivalent study using pre-and post-testing Sample: 75 undergraduate nursing students Variable: Assessment of acute pain in adults and newborns, online educational intervention Instrument: Online questionnaires Analysis: Independent t-test	Student's knowledge, attitudes, and behaviors to online educational intervention about acute pain management	A significant difference was seen in student learning ($p = 0.001$) in the post-test compared with the pre-test results. The students understood the importance of the topic and were satisfied and motivated by the technology and method applied. Using persuasive technology such as small mobile devices as mediators of online educational interventions broadens learning spaces in an innovative, flexible, motivational, and promising manner. The method used in this study motivated students to construct their knowledge and has the potential to promote changes in attitudes and behaviors concerning how students seek knowledge Video analysis supported the value of integrating either form of DP to improve communication and teamwork
[25]	Study design: A quasi-experimental design Sample: A total of 184 students participated Variable: Simulation virtual Instrument: Communication and teamwork strategies (briefing, SBAR, 3 Ws) were assessed through a retrospective video review and analysis of phase III multi-patient Sim-IPE Analysis: Probability Anderson-Darling Shapiro-Francia Shapiro-Wilk, normality tests	Communication and teamwork ability of students	Findings showed a significant improvement in the student's post-scenario knowledge ($Z = -6.506, P < 0.001$). The highest mean performance scores were obtained in the last scenario (mean = 19.7, median = 20.0, SD = 3.41), indicating a learning effect. Knowledge was not a predictor of students' performance in the scenarios
[17]	Study design: Pre-and post-test design Sample: A total of 166 second and third-year diplomas nursing students Variable: vSIM in improving student nurse's knowledge and performance during rapid patient deterioration Instrument: The simulation included three scenarios (cardiac-shock-respiratory) portraying deteriorating patients Analysis: Chi-square	Knowledge and performance during patient deterioration	

(Contd...)

Table 2: (Continued)

Authors and years	Study design, sample, variable, instrument, and analysis	The outcome of analysis factors	Summary of result
[35]	<p>Study design: The study used a pretest-post-test method</p> <p>Sample: Two hundred and forty-nine second-year undergraduate nursing and midwifery students</p> <p>Variable: Effect on student learning, satisfaction, and comfort following exposure to a 3D pharmacology artifact in a virtual facility (CAVE2™) with the viewing of the same artifact using a mobile handheld device with stereoscopic lenses attached</p> <p>Instrument: Online multiple-choice tests were deployed to measure knowledge acquisition. Self-reported satisfaction scores and comfort ratings were collected using questionnaires</p> <p>Analysis: Brown-Mood test, t-tests, Fisher's exact test</p> <p>Study design: Quasi experimental</p> <p>Sample: 20 nursing students</p> <p>Variable: A VR simulation focused on maintaining sterile technique during urinary catheterization</p> <p>Instrument: Questionnaires and video game</p> <p>Analysis: T-test</p>	<p>Student learning, student's satisfaction scores for clinical reasoning, and comfort</p>	<p>Simulation improves both knowledge about and performance during patient deterioration. vSIM of rare events should be a key component of undergraduate nurse education to prepare students to manage complex situations as practicing nurses</p> <p>Participants were not disadvantaged in terms of knowledge acquisition by using either CAVE2™ or the mobile handheld visualization mode (p = 0.977). Significant differences in favor of the CAVE2™ environment were found in between student's satisfaction scores for clinical reasoning (p = 0.013) and clinical learning (p < 0.001) compared to the handheld mode. There were no significant differences in satisfaction with debriefing and reflective practice exercises (p = 0.377) related to undertaking visualization activities. A small number of students using handheld devices with stereoscopic lenses reported more significant discomfort about the visualization that negatively impacted their learning (p = 0.001)</p> <p>Subjects (n = 20) rated the usability of the VR system favorably; they also rated practicing catheter insertion this way as highly engaging and enjoyable. Subjects using the VR system spent more time practicing (p = 0.001) and completed more procedures in 1 h than students who practiced traditionally (p < 0.001). Follow-up skill demonstration pass rates between groups were identical at 2 weeks. Practicing nursing skills using game-based VR may be an effective way to promote mastery learning and retention</p> <p>The experimental group made more significant improvements in knowledge after the intervention (p = 0.001; d = 1.13) and 2 months later (p = 0.02; d = 0.75), and it also showed higher levels of learning satisfaction (p < 0.001; d = 1.33). We did not find statistical differences in self-efficacy perceptions (p = 0.9; d = 0.054). The introduction of clinical vSIM in nursing education can improve knowledge retention and clinical reasoning in an initial stage and over time, and it increases the satisfaction with the learning experience among nursing students</p> <p>Both groups made modest knowledge gains. They made significant gains in self-efficacy scores, with the gaming group making greater gains. Satisfaction survey scores were high for both groups</p>
[18]	<p>Study design: Pre and post-test design</p> <p>Sample: Portuguese nursing students (n = 42)</p> <p>Variable: Clinical vSIM</p> <p>Instrument: Case-based learning approach, with the clinical virtual simulator and multiple-choice knowledge test</p> <p>Analysis: Kolmogorov-Smirnov test</p>	<p>Knowledge, learning satisfaction, clinical reasoning</p>	<p>The experimental group made more significant improvements in knowledge after the intervention (p = 0.001; d = 1.13) and 2 months later (p = 0.02; d = 0.75), and it also showed higher levels of learning satisfaction (p < 0.001; d = 1.33). We did not find statistical differences in self-efficacy perceptions (p = 0.9; d = 0.054). The introduction of clinical vSIM in nursing education can improve knowledge retention and clinical reasoning in an initial stage and over time, and it increases the satisfaction with the learning experience among nursing students</p> <p>Both groups made modest knowledge gains. They made significant gains in self-efficacy scores, with the gaming group making greater gains. Satisfaction survey scores were high for both groups</p>
[41]	<p>Study design: Quasi-experimental</p> <p>Sample: All current students who had completed the second year in a large</p> <p>Variable: A virtual gaming simulation with a laboratory simulation regarding three outcomes: students' pediatric knowledge, self-efficacy, and satisfaction</p> <p>Instrument: Case scenario</p> <p>Analysis: PASW statistics 18.0</p> <p>Chi-square dependent and independent t-test, descriptive statistics</p>	<p>Students' pediatric knowledge, self-efficacy, and satisfaction</p>	<p>Both groups made modest knowledge gains. They made significant gains in self-efficacy scores, with the gaming group making greater gains. Satisfaction survey scores were high for both groups</p>
[34]	<p>Study design: A cross-sectional descriptive study</p> <p>Sample: 132 registered nurses working at a hospital in Korea</p> <p>Variable: Newly graduated nurses' educational needs for WBS education</p> <p>Instrument: The survey consisted of 101 multiple-choice questions regarding demographics and educational needs</p> <p>Analysis: Data were analyzed using descriptive statistics, independent t-test ANOVA, and Scheffe test</p>	<p>Nurses need simulation training, nursing education needs</p>	<p>Most all (96.2%) participants said that new nurses need simulation training, and 90.2% of participants said WBS is necessary. The highest-ranked category was fundamental nursing knowledge, followed by fundamental nursing techniques. Among 81 items of nursing education needs, top-ranked items were cardiopulmonary resuscitation, care of artificial airways, oxygen therapy, and mechanical ventilation, mostly in the fundamental-nursing-techniques category. Educational needs significantly differed depending on participants' Clinical experience (F = 5.37; P = 0.006), hospital types (t = -3.48; P = 0.001), past experiences as a preceptor (t = 2.71; P = 0.008). WBS will help new nurses learn and adapt to the clinical setting, which can assist nurses in providing optimal care to patients with confidence</p>

MCI: Mass casualty incidents, ComED: Communication education, AC: Attention control, CHA: Comprehensive health assessment, SHAE: Symptom-focused health assessment and empathy, ANCOVA: Analyses of covariance, 3D: Three-dimensional, SD: Standard deviation, PASW: Predictive Analytics Software, WBS: web-based simulation, vSIM: Virtual simulation, VR: Virtual reality, SBAR: Situation, Background, Assessment, and Recommendation, HFPS: High-fidelity patient simulation, SVM: Simulation Virtual Method, IBM: International Business Machines, SPSS: Statistical Product and Service Solutions, Sim-IPE: simulation-enhanced interprofessional education, DP: Deliberate Practice, CAVE2: Cave Automatic Virtual Environment.

Participants with 4-6 years of clinical experience, working in a hospital with more than 300 beds, and with experience as a mentor, greatly influences the clinical education process [34]. Students who have not had much experience in practical fields, of course, will need more learning; that is, the current simulation method because in the pandemic era, so can use vSIMs.

Clinical skills

Virtual simulations effectively improve student skills in clinical nursing education. Students explain

that learning to apply theoretical knowledge while playing. The results showed that students who played with virtual applications were better at their clinical reasoning than those who did not play at all [43]. The research results on the use of suction tubes and peristomal care through the media of a game-based virtual reality telephone application showed that the student's final test scores in the experimental group were higher than the student's mean scores. Game-based virtual reality telephone applications effectively teach tracheostomy tube aspiration skills to nursing students in the short-term, and it is recommended

that these applications be used in psychomotor skills training [23].

Research on nurses and nursing students who completed the E-simulation program showed that the knowledge and performance of the two groups improved significantly without differences between groups. The analysis results obtained that the predictors of performance were the level of education, knowledge, experience, and female gender. Participants evaluate the program and its delivery methods positively. E-simulation can improve student preparation for practice and improve the quality of nurse management for deteriorating patients [2]. Increasing clinical assessment scores demonstrated the student's self-perception of clinical assessment ability. The study results show a statistically significant findings in the experiment and in students' self-perceptions of their clinical assessment abilities. Virtual simulations are beneficial to student learning and development in assessing clinical skills [9].

Mixed learning virtually effectively increases access to quality training and identifies midwifery skills. There are two treatments: Conventional learning (pre-intervention cohort) and mixed learning approach (post-intervention cohort). There was a significant difference in the mean scores of the pre-intervention and post-intervention groups. Mean scores for all six practices also increased significantly from pre-intervention to post-intervention (27). The student's psychomotor skills scores were higher in the virtual simulator group, and the self-confidence scores were similar in the two groups. Teaching with a virtual simulator contributes more to student skills than the method used in the form of video training [16]. Computer-based simulation programs enhance the laboratory simulation experience by encouraging individual student desires in laboratory learning. Computer-based simulation programs are effective for improving student learning [24]. Virtual simulation programs also promote positive attitudes. Teamwork was reported to be higher, while leadership and team coordination scored the highest. Participants' satisfaction with the vSIM program was also increased. Simulation-based learning programs effectively increase positive attitudes among student nurses [38]. Learning with vSIMs can foster a sense of responsibility and cooperation with the group because nursing actions are sometimes also carried out in a team. This program can also improve students' skills in communication. The results showed that as many as 184 students participated in virtual (26 teams) and supported the value of integration in improving communication and teamwork [25]. Computer-based vSIMs for new nurses should include basic nursing knowledge and techniques that can be applied to clinical practice immediately after learning. The use of vSIMs will help new nurses learn and adapt to clinical settings, which can assist nurses in providing optimal care to patients with confidence [34].

Conclusion

Virtual simulation effectively increases student knowledge of how to take action and collect information, the clinical reasoning process, fundamentals of nursing procedures, and performance during rapid patient deterioration in nursing clinical education. Virtual simulation effectively improves student skills. There are about suctioning a tracheostomy tube, concepts of triage using the Sort, Assess, Lifesaving Interventions, and Treatment/Transport model, clinical reasoning skills, clinical judgment skills, intravenous catheterization skills, improved prioritization, role-modeled nursing care, individualized preparedness, engaged critical thinking, decreased level of anxiety, and increased confidence in the laboratory, in clinical nursing education, interactive communication, and health assessment skills. The new findings, apart from knowledge and skills, are that vSIMs can also increase confidence, change attitudes, and behaviors, innovative, flexible, and promising manner of new nurses and nursing students.

Recommendations

Virtual simulation in clinical nursing education can be developed using various approaches or methods, including digital. In the future, it is necessary to develop a learning system in the clinic and a virtual practicum in the laboratory for nursing students. So that competence can still be obtained even though it is carried out virtually or online.

Supplementary information

Availability of data and materials

This is a systematic review and the findings elaborate on all of the included studies/data.

Declarations

Ethics approval and consent to participate.

This is a quick examination of what is already out there, and it does not require ethics approval.

Consent for Publication

The study's authors have all given their permission to be published.

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