Abstract: The use of technology-based learning methods in nursing education is necessary in the era of digitalization, but these methods are limited, especially in developing countries, including Indonesia. We aimed to evaluate the effectiveness of the Virtual Nursing Skills Simulation Lab (VNursLab), a web-based nursing skills simulation using 3D technology, to improve the knowledge of nursing skills for intravenous catheterization, satisfaction, and self-confidence of nursing students in Indonesia. A quasi-experimental design was used. A total of 139 nursing students participated and were divided into intervention and control groups (69 and 70 participants, respectively). The intervention group had access to the VNursLab 3D simulator for three weeks and had three meetings. The control group had traditional learning (lecture and three meetings). The data were analyzed using the paired t-test, Wilcoxon test, and Mann–Whitney U test. The means and standard deviations of the post-test values in the two groups for the three parameters were 12.26 + 4.11 vs. 9.67 + 3.13 for nursing skill knowledge, 23.00 + 2.32 vs. 21.70 + 2.68 for satisfaction, and 36.25 + 3.48 vs. 34.96 + 3.39 for self-confidence.

1. Introduction

Adapting to technological advances is important for clinicians in the digitalization era, especially nurses, to maintain high-quality standards and services [1]. Nursing education in Indonesia produces nurses with various educational qualifications and degrees. The learning medium contributes to the overall quality of nursing education [2,3]. Among the most encouraging developments in the learning process are digital-based learning methods.
The development of the digitalization era has had a significant impact on all sectors, including education [4,5]. As a result, institutions compete to develop learning innovations to improve the quality of the learning process [6]. Students are also expected to position themselves and adapt to digitalization in the education process [7]. The learning process in the future will combine conventional and digital method approaches to produce better outcomes. The classical method improves students’ interpersonal and communication skills, while digital methods and materials enhance their ability to gain knowledge and learn material more broadly and informatively with up-to-date knowledge [8,9]. As a result, students are generally more interested in participating in the learning process.

Models of education that focus on nursing theory and practice require particular technology-based interventions to facilitate learning [10]. With a touch of technology, nursing students can easily access both theoretical and practical materials [11]. The adaptation of learning through technology and technology-based learning procedures in the nursing field has become significant and necessary in the context of the COVID-19 pandemic. However, the availability of these technologies in Indonesia, especially in nursing education, is still minimal.

Learning through technology is a new challenge for nursing students [12]. Nursing educators and innovators are expected to develop new and innovative learning techniques using a digitalization approach. Previous research has shown that virtual reality lab-based learning can improve students’ ability and understanding during the learning process [12], as well as their communication, self-efficacy [13], critical problem analysis [11], self-confidence [14], and action skills. Moreover, the XYZ method, which uses web-based simulation, has been found to increase students’ satisfaction during the learning process [15]. In Indonesia, traditional learning approaches are widely used to teach theory and basic skills to nursing students. There are limited learning media based on technology and limited opportunities for students to develop their critical thinking.

A web-based innovation was designed for teaching to stimulate and develop students’ critical thinking. The guiding principles were that the innovation should use a case study approach, be simple and easy to access, be set in the Indonesian culture, and use the Bahasa Indonesian language. The innovation is titled the Virtual Nursing Skills Simulation Lab (VNursLab) and uses 3D technology.

**VNurslab 3D Simulator**

The VNursLab simulation has seven components: reading material, a pre-test, case studies, analysis of nursing plans, 3D simulation of nursing skills, a post-test, and a self-evaluation. The simulator suite can be accessed on the internet (https://vnurslab.com; accessed on 28 November 2021) via computers, laptops, and mobile phones. The reading material presents the concept of disease, nursing care plans, and important additional information. The reading materials available in the VNursLab 3D simulator include material about acute coronary syndrome, labor, pulmonary tuberculosis, Bacille Calmette–Guerin immunization, prenatal care, head injury, colon cancer, chronic obstructive pulmonary disease, strokes, Hirschsprung, schizophrenia, and dengue hemorrhagic fever.

The case studies were compiled on the basis of real patient scenarios in health services and reviewed by nurses working at national referral hospitals in Indonesia. These Indonesian registered nurses had a Master’s in Nursing and were clinical instructors in the clinical setting with a minimum of five years of work experience. The simulator contains 12 nursing skill simulation modules with 3D technology. Each module integrates the concepts of disease, case studies, and nursing skills. These concepts were compiled comprehensively, covering theories and nursing skills that have been reviewed by nursing experts. Nursing skills are presented in the form of a 3D simulator, which was prepared on the basis of standardized SOPs, such as basic life support, placenta removal procedures, oxygen insertion procedures, procedures for administering Bacille Calmette–Guerin immunization to infants, Leopold examination procedures, Glasgow Coma Scale measurements, colostomy treatments, postural drainage procedures, range of motion measures, wash out procedures,
therapeutic communication intervention, and IV catheterization procedures (Figure 1). Pre- and post-tests contain questions that have been reviewed on the basis of the nursing competency standards in Indonesia. To validate the VNursLab 3D simulator’s content and website, 17 experts (15 nursing experts and 2 experts in information technology) held a desk review. Experts in information technology were those who had experience and knowledge in developing websites with a minimum education level of master’s education. The results of the desk review showed that the VNursLab 3D simulator’s contents were appropriate for nursing students and the nursing profession. The website of VNursLab is user-friendly, easy to operate, and applicable as an innovative learning medium.

Figure 1. VNursLab 3D simulator: (a) homepage of VNursLab 3D simulator, (b) safety procedure before the intervention of IV catheterization, (c,d) preparation and implementation of IV catheterization.

As the VNursLab 3D simulator was designed to be an alternative learning medium for nursing students to achieve their competencies; evidence was needed to ensure that it was effective. This research analyzed the effectiveness of the VNursLab 3D simulator program compared with traditional learning for nursing students in Indonesia regarding IV catheterization for fluid therapy for patients with dengue hemorrhagic fever (DHF) topics.

2. Materials and Methods

2.1. Study Design

A quasi-experimental study design was used to establish a cause-and-effect relationship between the independent (type of learning medium) and dependent (level of nursing skills, satisfaction, and self-confidence) variables. This design was chosen because of difficulties in conducting randomization.

2.2. Sample and Setting

The study was conducted at the Faculty of Nursing in Universitas Padjadjaran, Bandung, Indonesia, from September to October 2021. Purposive sampling was used to recruit potential participants. Third-year undergraduate nursing students who had never attended clinical skills training in intravenous (IV) catheterization and had no clinical experience...
in this procedure were included. Students who did not follow the research process were excluded, including those who did not attend the pre- or post-test, were not present in the general lecture on IV catheterization, or did not use the VNursLab 3D simulator as instructed for the intervention group. A total of 139 students who met the inclusion criteria consented to participate in the study.

Participants were assigned to groups using a paper lottery with the student’s name, and they were advised of their group assignment following consent. The group sizes were $n = 69$ in the intervention group and $n = 70$ in the control group (Figure 2). All participants were required to attend a general lecture on IV catheterization, and those in the intervention group also utilized the VNursLab 3D simulator. To reduce contamination (participants in the intervention sharing with the control group) among students, we asked students not to discuss or share the research material, procedure, or information with others.

Figure 2. Research protocol.
2.3. Variables

The independent variable was the learning medium (VNursLab 3D simulator and traditional methods). In this study, the nursing skill and patient disease chosen to test the effectiveness of the VNursLab learning medium was IV catheterization for fluid therapy for patients with DHF. DHF was selected because it is an endemic disease and one of the most common tropical diseases in Indonesia. Hydration via IV catheterization is a procedure to overcome the fluid problems in DHF patients, and managing IV catheterization is a core competency for Indonesian nurses.

The dependent variable in this study was IV catheterization skill knowledge integrated with theories of fluid therapy in DHF, satisfaction, and self-confidence in learning.

2.4. Instruments

2.4.1. Intravenous (IV) Catheterization Skill Knowledge Questionnaire

This questionnaire was used to measure the participants’ knowledge of skills in IV catheterization for fluid therapy. The researchers developed this questionnaire on the basis of the IV catheterization standard operating procedures (SOPs) [16]. This involved revising sentences from the SOPs for research purposes. The questionnaire contained 20 sequences of IV catheterization procedures, and the participants were asked to sort them according to the SOPs. The questionnaire was comprised of multiple-choice questions (MCQ). Each correct sequence of the procedure was given a score of 1, and a score of 0 was given for the wrong sequence. The maximum score for this questionnaire was 20, and the minimum score was 0. The content validity of the questionnaire was undertaken by four experts in the medical surgical nursing field. The value of the Content Validity Index (CVI) average was 0.93, and the value was 0.75 for the CVI’s universal agreement. These experts had a master’s education in nursing, especially medical–surgical nursing, and were Indonesian registered nurses. The construct validity was tested by Pearson correlation with an r table. The value (r count) of all the questions was more than 0.361. The Cronbach alpha results for reliability were 0.877 to 0.893.

2.4.2. Student Satisfaction and Self-Confidence Questionnaire

The satisfaction and self-confidence questionnaires were adopted from a previous study [17]. We consulted with a bilingual Indonesian–English expert regarding the language translation. The construct validity for all questions was a minimum of r = 0.30, and the reliability test results were 0.77–0.85. The satisfaction questionnaire consisted of five questions, and the answer choices were “strongly agree”, “agree”, “neutral”, “disagree”, and “strongly disagree”, with scores 5, 4, 3, 2, and 1, respectively. The maximum value was 25, and the minimum value was 5. The construct validity was tested by Pearson correlation with an r table. The value (r count) of all the questions was more than 0.361. In the reliability test, Cronbach alpha values ranged from 0.718 to 0.753. The self-confidence questionnaire consisted of eight questions and contained the same options and scoring as the satisfaction questions. The maximum value was 40, and the minimum value was 8. The construct validity was tested by Pearson correlation with an r table. The value (r count) of all the questions was more than 0.361. In the reliability test, Cronbach alpha values ranged from 0.807 to 0.885.

2.5. Procedure

2.5.1. Intervention Group

In the intervention group, a total of 70 nursing students were given a pre-test to evaluate their knowledge of skills of IV catheterization. After that, they joined a lecture on the theories on DHF and important points about the IV catheterization procedure. In this group, each participant received the VNursLab 3D simulator to use for three weeks. Participants also engaged in three group meetings. In the first meeting, participants read the literature regarding DHF in VNursLab and completed the pre-test part of the simulator. In the second meeting, participants read the case study, decided on the nursing care plan,
and practiced IV catheterization through simulation using the VNursLab 3D simulator. In the third meeting, participants completed the post-test of VNursLab and wrote the self-evaluation in the simulator under a lecturer’s observation. Following the post-test, participants were given the class (or individual) post-test results to observe their knowledge of nursing skills regarding IV catheterization, satisfaction using the VNursLab 3D simulator, and self-confidence. One student dropped out during the intervention process ($n = 69$).

2.5.2. Control Group

In the control group, a pre-test on IV catheterization skills was implemented for 70 nursing students. Further, the students received a lecture that covered content on theories on DHF and the IV catheterization procedure. In the control group, we conducted conventional learning for three weeks with three meetings. Convention learning was implemented by the lecturer using slide presentations. In the first meeting, participants received the same lecture as the intervention group about DHF, and a question-and-answer session was also provided. In the second meeting, participants practiced IV catheterization via video. In the last meeting, participants implemented the IV catheterization at home and reported to the lecturer. Following the three weeks, the nursing students were given post-test questionnaires to rate their knowledge of nursing skills regarding IV catheterization, learning satisfaction, and self-confidence. No participants dropped out in this group (Figure 2).

2.6. Data Analysis

The researchers used IBM SPSS Windows version 25 to analyze the data. The data analysis stages included data management, coding, tabulation, processing, and presentation. Descriptive statistics were conducted to describe the characteristics of the participants. The Pearson Chi-square test and Fisher’s exact test were performed to analyze the homogeneity of the participant characteristics by group. The Shapiro–Wilk test was conducted to determine the normality of the variable data. Variables with a normal distribution were analyzed using a paired $t$-test, while other variables were analyzed using the Wilcoxon signed-rank test or the Mann–Whitney U test. There were two steps in the analysis: within-group and between-group.

2.7. Ethical Consideration

The Helsinki Ethical Principles were used in this research to respect human rights, including benefits of the study to the participants, not causing harm, and promoting justice. We received approval and ethical consideration from Universitas Padjadjaran with the number 731/UN6.KEP/EC/2021. Informed consent was given personally and signed by the participants manually.

3. Results

In general, no differences were found in the demographic characteristics of the participants by group, but there was a difference in internet stability. The majority of participants were female (90.6%), lived in rural areas (64.7%), and felt burdened with coursework during the COVID-19 pandemic. An issue related to the use of the VNursLab 3D simulator learning medium was that just over half of the participants in the intervention group (52.2%) had unstable internet connections, and this percentage was less than that in the control group (35.7%) (Table 1). Even though they were not using the VNursLab 3D simulator in their learning of IV catheterization and DHF, their classes were online. The unstable internet connection is a national issue, especially in rural areas of Indonesia.
Table 1. Distribution of participants’ characteristics (n = 139).

| Characteristic                  | Group          | Intervention (n = 69) | Control (n = 70) | Total (n = 139) | Statistical Analysis |
|--------------------------------|----------------|----------------------|------------------|----------------|---------------------|
|                                |                | n (%)                | n (%)            | n (%)          |                     |
| Gender                         | Male           | 6 (8.7)              | 7 (10.0)         | 13 (9.4)       | p = 0.792<sup>a</sup> |
|                                | Female         | 63 (91.3)            | 63 (90.0)        | 126 (90.6)     |                     |
| Domicile                       | Rural          | 49 (71.0)            | 41 (58.6)        | 90 (64.7)      | p = 0.125<sup>a</sup> |
|                                | Urban          | 20 (29.0)            | 29 (41.4)        | 49 (35.3)      |                     |
| Internet connection            | Stable         | 33 (47.8)            | 45 (64.3)        | 78 (56.1)      | p = 0.051<sup>a</sup> |
|                                | Unstable       | 36 (52.2)            | 25 (35.7)        | 61 (43.9)      |                     |
| Self-desire to study in nursing| Yes            | 68 (98.6)            | 65 (92.9)        | 133 (95.7)     | p = 0.209<sup>b</sup> |
|                                | No             | 1 (1.4)              | 5 (7.1)          | 6 (4.3)        |                     |
| Feeling burdened with coursework| Yes           | 56 (81.2)            | 56 (80.0)        | 112 (80.6)     | p = 0.863<sup>a</sup> |
|                                | No             | 13 (18.8)            | 14 (20.0)        | 27 (19.4)      |                     |

<sup>a</sup> Pearson Chi-Square Test; <sup>b</sup> Fisher’s Exact Test.

The pre-test results showed that the intervention group had more knowledge of the topic at the start of the study compared with the control group (9.80 vs. 7.76). While both groups’ mean scores on knowledge increased from the pre- to the post-period, the increase was greater (a mean gain of 2.46) for the intervention group compared with the control groups (a mean gain of 1.91).

The means and standard deviations of the participants’ knowledge of nursing skills obtained from the pre-test were 9.80 + 3.04 in the intervention group and 7.76 + 2.95 in the control group. The intervention group’s post-test score was 12.26 + 4.11, and the post-test score was 9.67 + 3.13 in the control group. The statistical analysis showed a significant difference in the mean knowledge of nursing skills score between the intervention and control groups (p < 0.05). The average score of satisfaction in the participants’ learning was 23.00 + 2.32 in the intervention group and 21.70 + 2.68 in the control group. Statistically, there was a difference in the mean satisfaction score between the intervention and control groups (p < 0.05). The mean score of the participants’ self-confidence when learning in the intervention group was 36.25 + 3.48, and this score was 34.96 + 3.39 in the control group. There was a statistically significant difference in the mean score of the participants’ self-confidence when learning between the intervention and control groups (p < 0.05) (Table 2).

Table 2. Effectiveness of web-based simulation between intervention and control groups.

| Variable                        | Group          | Mean + SD      | p               |
|---------------------------------|----------------|----------------|-----------------|
| Knowledge of nursing skills     | Pre-test       | Intervention   | 9.80 + 3.04     | p < 0.001<sup>a</sup> |
|                                 |                | Post-test      | 12.26 + 4.11    |                 |
|                                 | Pre-test       | Control        | 7.76 + 2.95     | p < 0.001<sup>b</sup> |
|                                 | Post-test      | Intervention   | 9.67 + 3.13     |                 |
|                                 |                | Control        | 9.67 + 3.13     |                 |
| Satisfaction in learning        | Post-test      | Intervention   | 23.00 + 2.32    | p < 0.001<sup>c</sup> |
|                                 |                | Control        | 21.70 + 2.68    |                 |
| Self-confidence in learning     | Post-test      | Intervention   | 36.25 + 3.48    | p = 0.014<sup>c</sup> |
|                                 |                | Control        | 34.96 + 3.39    |                 |

<sup>a</sup> Paired t-test; <sup>b</sup> Wilcoxon signed-rank test; <sup>c</sup> Mann–Whitney U Test.
4. Discussion

4.1. Nursing Skills and Competencies

The analysis of the results showed a significant difference in knowledge of nursing skills between the intervention and control groups regarding IV catheterization skills for fluid therapy. Of significance is that in the post-test, the control group’s knowledge scores remained below those of the intervention group in the pre-test. The features of the VNursLab 3D simulator, including reading materials, pre- and post-tests, case studies, nursing skill simulations, and self-evaluations, provide students with different learning experiences. There are four conditions in problem-based learning: patient-based; digital patient-based; study case-based; and traditional learning methods, in which the lecturer dictates cases to students [17]. Patients or case studies visually presented in media education motivate and increase the observational ability of the students during learning compared with paper-based methods [18]. A previous study found that learning with actual patients is a substantial learning trigger [19]. Hence, learning has not been fully implemented for nursing students who have not been directly involved in the clinical field; therefore, appropriate learning methods should facilitate the fulfillment of student competencies. Combining these learning methods can be useful for nursing students in the preclinical phase to help solidify their competency. Combining visual learning methods (simulation e-learning) with patient cases (problem-based learning) can aid students in practical problem-solving [20–22].

Learning through the use of the VNursLab 3D simulator can improve the student’s understanding of IV catheterization skills for fluid therapy. The VNursLab 3D simulator presents an animated simulation of a nurse performing an IV catheterization for fluid therapy. The users can determine the series of actions with the help of the program, which is set according to the SOPs for IV catheter insertion. Visual forms of simulation have been widely used on websites for learning purposes. The techniques, tools, and strategies in web-based simulations can be applied when designing structured learning experiences and measuring tools related to targeted competencies [23]. Studies on web-based simulation learning have been proven to result in the significant improvement of intramuscular injection skills [24], drug dose calculation [25], urinary catheterization [26], and diabetic foot examination [27], as well as nurse communication skills [28]. The visual experience is the first feature that a simulator user experiences. When the user sees the patient and equipment on the simulator, there is a visual interpretation of the subject and object. The brain then processes, organizes, and challenges the user to think on a level that requires higher-order thinking skills [29]. In addition to the experience of the user, in designing a simulation, an instructor needs to determine how the simulation should be created to facilitate the maximum development of students’ critical thinking when dealing with patients with particular conditions [30]. The incorporation of learning methods on the VNursLab 3D simulator can generate new insight and help nursing students achieve targeted competencies when learning. This is because the VNursLab 3D simulator combines a web-based nursing action simulation-based learning method and case study learning adopted from real patients in hospitals.

4.2. Satisfaction

Significant differences were found in the control and intervention groups. VNursLab provides a learning experience that is different from conventional learning in general. The new experiences offered by the VNursLab 3D simulator significantly increase learning satisfaction. In conventional learning, learning only occurs in the classroom with practice in the laboratory. The VNursLab 3D simulator provides a different experience. Research on student satisfaction due to the modification of the instructional media was found to be related to child drug administration [31] and midwifery [32] skills. Active learning in web-based simulations offers students cognitive, psychological, and other skills, helping them in assisting patients [33]. In addition, the learning conditions in web-based simulations are seen as safer and more comfortable than those in conventional learning [34]. The results of
this study strengthen the previous research because the VNursLab 3D simulator presents case studies and action simulations that involve different learning media. It challenges students to solve problems correctly and provides a clinical picture that students will face when practicing in hospitals.

4.3. Self-Confidence in Learning

The students’ self-confidence in the intervention group was significantly different from that of the control group. VNursLab 3D simulator users can take advantage of its features as much as they need. This repetition can improve the level of student preparation before undertaking nursing actions. Good preparation, easy accessibility, and simulator realism can increase students’ confidence [35]. Previous research has revealed that learning through web-based simulations is able to increase students’ confidence levels when inserting a peripheral IV catheter [36], performing intramuscular injection [24], performing urinary catheterization [37], and engaging in the management of post-partum bleeding [38]. Students evaluate themselves during learning and repetition and prepare for better learning outcomes [39]. The support and opportunities offered by web-based learning media can ultimately increase students’ self-confidence [40]. Student confidence is strengthened through the use of the VNursLab 3D simulator, which facilitates access, repeats the learning materials, improves students’ familiarity with the clinical environment, and improves student nursing practice preparation.

4.4. Limitations

The study was only conducted at one university. Although students were advised not to discuss their learning, the risk of contamination of research information among students may have happened. Overall mean knowledge gains by each group were small, and it is not known if this was a result of the post-test being conducted for research purposes. The results may have differed if the test had been an academic test that contributed to course marks. The low overall results may also be reflective of the knowledge questionnaire. The VNursLab 3D simulator has been shown to be effective at improving students’ IV catheterization comprehension skills, satisfaction, and confidence in learning. However, this medium cannot replace hands-on patient practice. On the other hand, the VNursLab 3D simulator can be an alternative when online learning becomes monotonous and creates a boredom effect.

5. Conclusions

The VNursLab 3D simulator as an alternative learning medium in the form of a web-based simulation improved nursing students’ knowledge of nursing skills, satisfaction, and self-confidence regarding IV catheterization in fluid therapy for DHF patients. Providing an opportunity to learn when students are able is important, especially given difficulties with internet stability. Simulation-based learning provides important experience regarding cases, situations, and conditions that students may encounter in the clinical field. The VNursLab 3D simulator can be recommended as an innovative learning medium for nursing students and to prepare them for a nursing profession, but further research into other nursing action simulators is needed to demonstrate the merits of this learning medium. However, this learning medium cannot replace direct practical learning with patients. Combining two learning methods—digital patient-based learning and hands-on practical learning with patients—will help nursing students gain competencies through a problem-based learning approach.

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References
1. Tsai, S.-Y. The nursing profession in a globalizing world. Hu Li Za Zhi J. Nurs. 2020, 67, 4–5. [CrossRef]
2. Lahti, M.; Haapaniemi-Kahala, H.; Salminen, L. Use of social media by nurse educator students: An exploratory survey. Open Nurs. J. 2017, 11, 26–33. [CrossRef] [PubMed]
3. Tuominen, R.; Stolt, M.; Salminen, L. Social media in nursing education: The view of the students. Educ. Res. Int. 2014, 2014, 929245. [CrossRef]
4. Iivari, N.; Sharma, S.; Ventä-Olkkonen, L. Digital transformation of everyday life—How COVID-19 pandemic transformed the basic education of the young generation and why information management research should care? Int. J. Inf. Manag. 2020, 55, 102183. [CrossRef]
5. Sima, V.; Gheorghe, I.G.; Subić, J.; Nancu, D. Influences of the industry 4.0 revolution on the human capital development and consumer behavior: A systematic review. Sustainability 2020, 12, 4035. [CrossRef]
6. Serdyukov, P. Innovation in education: What works, what doesn’t, and what to do about it? J. Res. Innov. Teach. Learn. 2017, 10, 4–33. [CrossRef]
7. Usher, M.; Barak, M.; Haick, H. Online vs. on-campus higher education: Exploring innovation in students’ self-reports and students’ learning products. Think. Ski. Creat. 2021, 42, 100965. [CrossRef]
8. Coman, C.; Tiru, L.G.; Mesean-Schmitz, L.; Stanciu, C.; Bularca, M.C. Online teaching and learning in higher education during the coronavirus pandemic: Students’ perspective. Sustainability 2020, 12, 10367. [CrossRef]
9. Norman, E.; Furnes, B. The relationship between metacognitive experiences and learning: Is there a difference between digital and non-digital study media? Comput. Hum. Behav. 2016, 54, 301–309. [CrossRef]
10. Darvish, A.; Bahramnezhad, F.; Keyhanian, S.; Navidhamidi, M. The role of nursing informatics on promoting quality of health care and the need for appropriate education. Glob. J. Health Sci. 2014, 6, 11–18. [CrossRef]
11. Matsika, C.; Zhou, M. Factors affecting the adoption and use of AVR technology in higher and tertiary education. Technol. Soc. 2021, 67, 101694. [CrossRef]
12. Thapa, P.; Bhandari, S.L.; Pathak, S. Nursing students’ attitude on the practice of e-learning: A cross-sectional survey amid COVID-19 in Nepal. PLoS ONE 2021, 16, e0253651. [CrossRef] [PubMed]
13. Hwang, G.-J.; Chang, C.-Y.; Ogata, H. The effectiveness of the virtual patient-based social learning approach in undergraduate nursing education: A quasi-experimental study. Nurse Educ. Today 2022, 108, 105164. [CrossRef] [PubMed]
14. Hudder, K.; Buck-McFadyen, E.; Regts, M.; Bushuk, K. A quasi-experimental study comparing virtual simulation to lab-based learning of newborn assessment among nursing students. Clin. Simul. Nurs. 2021, 55, 59–66. [CrossRef]
15. Cant, R.P.; Cooper, S.J. Simulation in the internet age: The place of web-based simulation in nursing education. An integrative review. Nurse Educ. Today 2014, 34, 1435–1442. [CrossRef] [PubMed]
16. Unver, V.; Basak, T.; Watts, P.; Gaioso, V.; Moss, J.; Tasta, S.; Iyiğun, E.; Tosun, N. The reliability and validity of three questionnaires: The Student Satisfaction and Self-Confidence in Learning Scale, Simulation Design Scale, and Educational Practices Questionnaire. Contemp. Nurse 2017, 53, 60–74. [CrossRef]
17. Li, J.; Li, Q.L.; Li, J.; Chen, M.L.; Xie, H.F.; Li, Y.P.; Chen, X. Comparison of three problem-based learning conditions (real patients, digital and paper) with lecture-based learning in a dermatology course: A prospective randomized study from China. Med. Teach. 2013, 35, e963–e970. [CrossRef]
18. Chan, L.K.; Patil, N.G.; Chen, J.Y.; Lam, J.C.M.; Lau, C.S.; Ip, M.S.M. Advantages of video trigger in problem-based learning. Med. Teach. 2010, 32, 760–765. [CrossRef]
19. Diemers, A.D.; Dolmans, D.H.J.M.; Santen, M.V.; Luijk, S.J.V.; Janssen-Noordman, A.M.B.; Scherpbier, A.J.J.A. Students’ perceptions of early patient encounters in a PBL curriculum: A first evaluation of the Maastricht experience. Med. Teach. 2007, 29, 135–142. [CrossRef]
20. Widiasih, R.; Hermayanti, Y.; Ermiati, E. International students’ experience of studying at Indonesian Universities. *J. Int. Stud.* 2020, 10, 24–43. [CrossRef]

21. Phungsuk, R.; Viriyavejakul, C.; Ratanaolarn, T. Development of a problem-based learning model via a virtual learning environment. *Kasetsart J. Soc. Sci.* 2017, 38, 297–306. [CrossRef]

22. Chernikova, O.; Heitzmann, N.; Stadler, M.; Holzberger, D.; Seidel, T.; Fischer, F. Simulation-based learning in higher education: A meta-analysis. *Rev. Educ. Res.* 2020, 90, 499–541. [CrossRef]

23. Lateef, F. Simulation-based learning: Just like the real thing. *J. Emerg. Trauma Shock* 2010, 3, 348. [CrossRef] [PubMed]

24. Erol, A.; Zaybak, A. The effect of web-based education on the learning of intramuscular injection of nursing students: A quasi-experimental study. *Int. J. Caring Sci.* 2017, 34, 802–808. [CrossRef]

25. Öztürk, D.; Dinç, L. Effect of web-based education on nursing students’ urinary catheterization knowledge and skills. *Nurse Educ. Today* 2014, 34, 802–808. [CrossRef]

26. Inkaya, B.V.; Tuzer, H.; Elcin, M. The impact of simulation-based education on students’ knowledge and skills in diabetic foot examination. *Int. J. Caring Sci.* 2020, 13, 431–437.

27. Ormanc, Ü.; Çepni, S. Investigating the effects of web-based science material for guided inquiry approach on information and communication skills of students. *Particip. Educ. Res.* 2020, 7, 201–219. [CrossRef]

28. Olsson, C.; Heggdal, K.; Tvedt, C.R. Elements in scenario-based simulation associated with nursing students’ self-confidence and satisfaction: A cross-sectional study. *Nurs. Open* 2020, 7, 170–179. [CrossRef] [PubMed]

29. Arrue, M.; Zarandona, J.; Hoyos Cillero, I. Nursing students’ alternative beliefs regarding care for patients suffering from depression. *Nurse Educ. Pract.* 2018, 29, 185–190. [CrossRef] [PubMed]

30. Kerr, D.; Ratcliff, J.; Tabb, L.; Walter, R. Undergraduate nursing student perceptions of directed self-guidance in a learning laboratory: An educational strategy to enhance confidence and workplace readiness. *Nurse Educ. Pract.* 2020, 42, 102669. [CrossRef]

31. Onder, H.E.; Sari, D. Simulation-based teaching is effective in developing peripheral intravenous catheterization skills. *Int. J. Caring Sci.* 2021, 14, 309–318.

32. Rodríguez-Diez, M.C.; Diez, N.; Merino, I.; Velis, J.M.; Tienza, A.; Robles-Garcia, J.E. Simulators help improve student confidence to acquire skills in urology. *Actas Urológicas Españolas* 2014, 38, 367–372. [CrossRef]

33. Rashidi Fakari, F.; Kordi, M.; Khadivzadeh, T.; Reza Mazloum, S.; Akhlaghi, F.; Tara, M. Effects of web-based training and educational simulation on midwifery students' self-confidence in postpartum hemorrhage management. *J. Midwifery Reprod. Health* 2015, 3, 262–268. [CrossRef]

34. Delaram; Toutouchi. Comparing self- and teacher-assessment in obstetric clerkship course for midwifery students of shahrekord university of medical sciences. *Iran. J. Med. Educ.* 2009, 3, 231–238.

35. Smith, S.J.; Barry, D.G. An innovative approach to preparing nursing students for care of the elderly in the home. *Geriatr. Nurs.* 2013, 34, 30–34. [CrossRef]