



ORIGINAL ARTICLE

Medicine Science 2024;13(3):681-8

The effect of web-based education on psychomotor skills education in nursing: Randomized controlled clinical trial

 Hakime Aslan¹, Seher Cevik Aktura²¹*İnönü University, Faculty of Nursing, Department of Fundamental Nursing, Malatya, Türkiye*²*Firat University, Faculty of Health Sciences, Department of Fundamental Nursing, Elazığ, Türkiye*

Received 03 July 2024; Accepted 09 August 2024

Available online 23 August 2024 with doi: 10.5455/medscience.2024.07.068

Content of this journal is licensed under a Creative Commons Attribution-NonCommercial-NonDerivatives 4.0 International License.



Abstract

This research was conducted to evaluate the effect of web-based education on psychomotor skills teaching and information levels in nursing students. The research is a randomized controlled clinical trial. The sample consisted of 90 students. In order to collect data, intravenous-Intramuscular injection skill checklists and drug administration knowledge tests created by the researchers were used. According to the post test; it was determined that the mean scores of intravenous catheterization and intramuscular injection skill scores of the students in the experimental group were statistically higher than the control group ($p=0.000$, effect size $d=1.399$, 1.347 respectively). In addition, it was determined that the information tests point average of the students in the experimental group (69.73 ± 8.81) was higher than that of the control group (58.37 ± 8.53), and the difference between the groups was statistically significant ($p=0.000$, effect size $d=1.310$). As a result, it was determined that web-based education increased the psychomotor skills and information levels of nursing students.

Keywords: Education, injections, nursing, psychomotor skills, web

Introduction

The traditional method for acquiring basic skills in nursing is through demonstration. While it offers numerous advantages, the high number of students in nursing schools, a shortage of qualified lecturers, and limited resources reveal the inadequacies of the demonstration method [1]. Additionally, clinical practice, a fundamental aspect of nursing education, faces challenges due to the limited availability of clinical sites for student placements, staff shortages, and nurses' reluctance to support student learning because of their heavy workloads. Given these challenges, the search for new teaching methodologies aligns with the advancements in technology [2].

The widespread use of the internet has fostered greater independence and self-improvement among students, significantly enhancing various educational fields, including nursing. Recently, web-based methods have become popular, offering an effective alternative to traditional classroom instruction [3]. Web-based learning occurs through the use of specialized information

sources, such as email and web searches, allowing students to enhance their learning by connecting to an expansive network. This approach facilitates convenient access to information, is cost-effective for both nurses and nursing students, and allows for learning from home, catering to those with limited study time or who cannot enroll in traditional daytime programs [4]. Furthermore, because it does not rely on physical materials, web-based learning can achieve broader reach than traditional methods, enhancing individual and group interaction [5]. A web-based learning environment enriched with audio, video, graphics, and two- or three-dimensional animations, alongside materials designed for instant feedback, provides a more engaging and lasting learning experience. Hence, web-based learning emerges as a significant alternative for teaching psychomotor nursing skills [6]. In nursing, intramuscular injection (IM) and intravenous catheterization (IV) are commonly practiced skills. Ensuring consistency in these practices, safely executing skills to avoid errors and threats to patient safety, and creating an enjoyable learning environment are of utmost importance [7].

CITATION

Aslan H, Cevik Aktura S. The effect of web-based education on psychomotor skills education in nursing: Randomized controlled clinical trial. Med Science. 2024;13(3):681-8.



Corresponding Author: Hakime Aslan, İnönü University, Faculty of Nursing, Department of Fundamental Nursing, Malatya, Türkiye
Email: hakime.aslan@inonu.edu.tr

Achieving this requires enhancing traditional learning methods and skill laboratories with information technology before their implementation.

This study aims to explore the impact of web-based education on nursing students' skills and knowledge levels in IM injections and IV catheterization.

Material and Methods

Design and Setting

This study was structured as a randomized controlled clinical trial model (Clinical Trial number: NCT06405191). It involved first-year nursing students from a university's nursing faculty, conducted between March and December 2021. The research population comprised first-year nursing department students at the university (N=269). To determine the necessary sample size, a power analysis was conducted using G-Power v3.1.9.4 (Heinrich Heine University, Dusseldorf, Germany) for Windows (Microsoft Inc., Redmond, WA, USA). The analysis indicated that the minimum sample size needed for the independent sample t-test was 82, with a 95% confidence interval (CI), a significance level (α) of 0.05, a power (1- β error probability) of 0.85, and an effect size (d) of 0.6 [8]. All students were included in the study. 15 students were excluded because they did not meet the inclusion criteria, 112 students were excluded because they refused to participate in the study, 30 students were excluded for other reasons (absenteeism, illness, etc.), and 2 students were excluded because they did not continue the study after starting it, and the study was completed with 90 students.

Randomization: Assignments of students to the experimental and control groups were made using the simple randomization method (<https://www.randomizer.org/>). Students who met the inclusion criteria and agreed to participate in the study were ranked according to student number. A computerised randomisation method was then used. The 92 students were randomly divided into two groups: the experimental group (EG) and the control group (CG) (2 sets of 46 numbers each, with numbers per set ranging from 1 to 92).

Inclusion criteria: Students who volunteered for the study, were taking the nursing basics course for the first time, had not graduated from a health vocational high school or possessed any associate or undergraduate degree from health-related departments, had internet access, and owned a smartphone or computer were included in the study.

Exclusion criteria: Students with any psychological diagnosis or those who submitted incomplete or incorrectly filled forms were excluded from the study.

Measures

The "Information Form," which gathers data on the socio-demographic characteristics, the "Academic Information Test" developed by the researcher to assess the academic knowledge level of the students, and the "IM Injection and IV Catheterization Skill Assessment Checklist" for evaluating their psychomotor skills, were used in this study.

Information Form

The form was designed by the researchers. It consists of 7 questions, including the socio-demographic characteristics of the students (age, gender, level of education) and their views on nursing education (willing to choose the nursing department, wanting the courses to be taught online, using the internet to learn psychomotor skills, thinking that web-based education is effective).

Academic Information Test

This form was developed by the researchers to assess students' knowledge levels regarding drug administration. It comprises 20 closed-ended questions, with students earning 5 points for each correct answer. Therefore, students can achieve a total score ranging from 0 to 100 on the knowledge test [9-12]. To evaluate the relevance and suitability of the questions, feedback was solicited from 8 faculty members specializing in nursing principles. These experts were asked to rate each question on its ability to measure knowledge about drug administration and the clarity of the questions on a scale from 1 to 4, where 1 represents "not suitable," 2 means "needs adaptation," 3 indicates "appropriate but requires minor changes," and 4 denotes "very suitable." The consensus among the experts was analyzed using Kendall's W analysis. The differences in scores assigned by the experts were not statistically significant (Kendall W=0.301; $p=0.545$), indicating a general agreement among them.

Psychomotor Skill Assessment Checklist

Researchers developed a specific checklist for each skill, drawing from existing checklists found in nursing textbooks and related literature [9,10]. The employment of skill-specific checklists facilitates an objective evaluation of psychomotor skill proficiency. Two skill checklists were devised; scoring was allocated as follows: 0 points if the skill was not performed or performed incorrectly, 1 point for partially correct performance, and 2 points for correct execution. The total score was derived by summing the points obtained on each checklist. The checklists and their scoring system are detailed below:

- 23 items for IM injection, with a scoring range of 0-46 points,
- 24 items for IV catheterization, with a scoring range of 0-48 points.

The Educational Intervention

First, the subject of drug administration was theoretically explained to all students in both the experimental and control groups. The theoretical training was delivered face-to-face to both groups. Additionally, students in both groups were demonstrated the clinical skills in the laboratory using the demonstration method. For EG, a web page was designed in collaboration with a software engineer. The link to the web page (<https://inonuhemsirelikesaslari.com>, which cannot be accessed currently as the page has expired) was shared with the students in EG. Videos of theoretical training and the application process for IV catheterization and IM injection skills were recorded,

uploaded to the web page, and made accessible to EG. Students in EG were provided with a username and password to access the web page, and their access was monitored by the researcher. The researcher could track each student's video viewing frequency and their scores on online tests. Students who did not watch the videos or take the tests were contacted for an interview, and feedback was provided to encourage them to engage with the materials. Students could access the web page as often as they liked for one month. Access to this web page was restricted for students in CG. In the post-test, the differences in average knowledge scores between the groups were assessed using a knowledge test and a skill test.

Data Collection and Analysis

We gathered data from students through face-to-face interviews and observation techniques. Information about their descriptive characteristics was collected as pre-test data from students in both groups. A faculty member specializing in the fundamentals of nursing theoretically explained the subject of drug administration to the students. The skills of IV catheterization and IM injection

were demonstrated to both groups by the researchers using models. Each student performed IV catheterization and IM injection on models at least once, with the opportunity to repeat the practices as many times as desired in the laboratory for one week. Post-test data were collected one week after the laboratory practices. For the information test, we administered a 30-minute theoretical exam to the students. To evaluate the students' practical skills, IV catheterization and IM injection were performed on arm and hip models, respectively. We assessed the students' skills using checklists that outlined the procedural steps, allotting each student 5 minutes to complete a skill. The reliability of the skill observation form was verified by assessing the agreement between two independent observers. The Kendall Tau coefficient was calculated as $r=0.825$, indicating "very good" reliability for the skill observation form.

One student from EG who did not participate in the laboratory practice and one student from CG who was absent from the post-test measurement were excluded from the study. Consequently, the study was completed with 90 students: 45 in EG and 45 in CG (Figure 1).

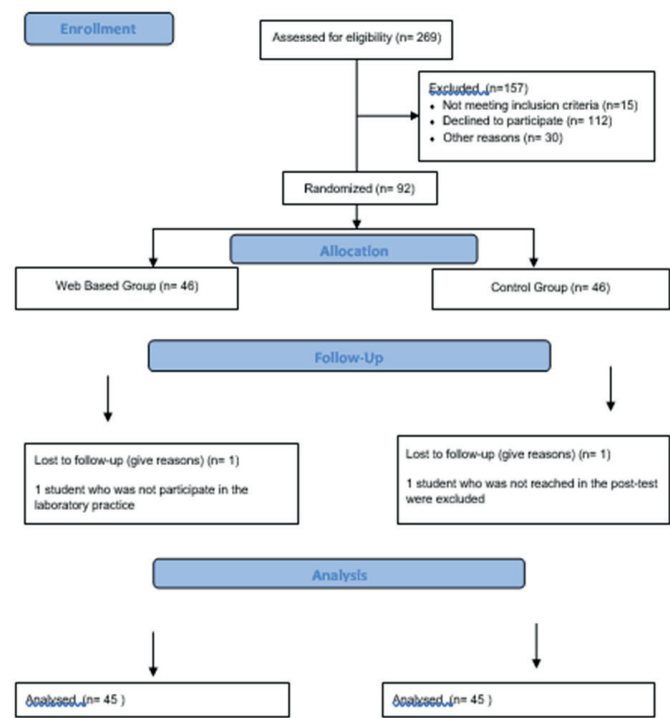


Figure 1. Consort diagram

Statistical Analysis

Data were analyzed using the IBM SPSS 22 software, a tool for social science statistics. Analytical techniques applied in evaluating the data encompassed calculation of percentages, averages, and variability measures, alongside the employment of the Chi-square test to examine differences in control variables between the Experimental and Control groups. To contrast the average scores of these groups, the t-test for independent

samples was used. The adherence of dependent variables to a normal distribution was verified through the Shapiro-Wilk test. Furthermore, to assess the impact of various independent variables on the training's efficacy, Multivariate Analysis within the Linear model framework was executed.

Blinding

Blinding between researchers was not possible, and the experimental and control groups were determined by simple

randomisation to avoid selection bias. The students were unaware that they were in the experimental or control group.

Ethical Considerations

Authorization for the study (2021/1454) was secured from the Scientific Research and Publication Ethics Committee of Health Sciences at İnönü University. Consent was also obtained from the dean of the faculty. Participants were thoroughly briefed about the study's aims, reassured about their freedom to disengage at any point, and their consent, whether in writing or orally, was recorded.

Results

The differences in socio-demographic characteristics and control variables of the students participating in the study are presented

in Table 1. The mean age of students in EG was found to be 19.8±1.07, compared to 19.4±1.57 in CG. In the EG, 62.2% of the students were female, 77.8% were graduates of Anatolian high schools, and 42.2% had chosen the nursing department partly willingly. In the CG, 71.1% were female, 88.9% were graduates of Anatolian high schools, and 42.2% had partly chosen the nursing department willingly. The willingness to choose the nursing department is significant for the provision of quality nursing care. Approximately half of the students in both groups had chosen the nursing department partly willingly. Nursing continues to be a preferred and respected profession in Türkiye. It was determined that the differences in socio-demographic variables between the students were not significant (p>0.05), indicating that the groups were similar in characteristics (Table 1).

Table 1. Comparison of students' socio-demographic characteristics

Characteristics	Web based group n=45		Control group n=45		Test and significance
	X±SD		X±SD		
Age	19.8±1.07		19.4±1.57		t =1.171 p=.245
	N	%	N	%	
Gender					
Female	28	62.2	32	71.1	x²=.053 p=.459
Male	17	37.8	13	28.9	
Graduated school					
Anatolian high school	35	77.8	40	88.9	x²=2.001 p=.129
Science high school	10	22.2	5	11.1	
Did you choose the nursing department willingly?					
Yes	12	26.7	9	20.0	x²=.719 p=.698
No	14	31.1	17	37.8	
Partly willingly	19	42.2	19	42.2	
Status of requesting lessons to be processed online					
Yes	2	4.4	4	8.9	x²=.715 p=.700
No	20	44.4	19	42.2	
Some lessons can be taught	23	51.1	22	48.9	
Status of using the internet to learn psychomotor skills					
Yes	34	75.6	39	86.6	x²=.257 p=.802
No	11	24.4	6	13.4	
The status of thinking that web-based education to be effective					
Yes, it is effective	17	37.8	5	11.1	x²=3.536 p=.171
No, it is not effective	5	11.1	16	35.6	
Partially effective	23	51.1	24	53.3	

X: mean, SD: standard deviation, N: number, x²: Chi-Square tests

Table 2 shows the comparison of the EG and CG pre and post-test mean scores between and in groups. According to these results; it was determined that the students in the EG had higher IV catheterization skills than the students in the CG (EG: 39.32±3.2, CG: 33.61±4.8, effect size (d)=1.399, p<0.001). IV catheterization application skill mean scores of the students in the EG increased significantly in the post-test (Pre-test: 30.55±4.5, Post-test: 39.32±3.2, p=0.000) (Table 2).

The students in the EG had higher IM injection skills than the students in the CG (EG: 38.51±2.6, CG: 33.31±4, effect size (d)=1.347, p<0.001). IM injection skill mean scores of the

students in the EG increased significantly in the post-test (Pre-test: 32.25±3.6, Post-test: 38.51±2.6, p=0.000) (Table 3).

Similarly, the difference between the information levels of the EG and CG's and their post-test mean scores was also found to be statistically significant. The students in the EG had higher information levels than the students in the CG (EG: 69.73±8.81, CG: 58.37±8.53, effect size (d)=1.313, p<0.001). The post-test mean score of the students in the EG increased, and a statistically significant difference was found between their pre-and post-test information level (Pre-test:51.23±3.8, Post-test: 69.73±8.8, p=0.000) (Table 4).

Table 2. Comparison of pre- and post-test mean scores of IV catheterization skills of students'

IV catheterization					
	Pre-test X±SD	Post-test X±SD	Test	Significance	Effect size (d)
Experimental group	30.55±4.5	39.32±3.2	9.254	.000**	2.246
Control group	31.21±4.8	33.61±4.8	1.254	.075	0.5
	t=.605 p=0.276 d=0.141	t=6.252 p=.000** d=1.399			

X: mean, SD: standard deviation, t: independent sample t test, **p<0.001

Table 3. Comparison of pre- and post-test mean scores of im injection skills of students'

IM injection					
	Pre-test X±SD	Post-test X±SD	Test	Significance	Effect size (d)
Experimental group	32.25±3.6	38.51±2.6	5.254	.000**	1.993
Control group	32.19±5.2	33.31±4.8	.978	.453	0.223
	t=.701 p=.720 d=0.013	t=6.701 p=.000** d=1.347			

X: mean, SD: standard deviation, t: independent sample t test, **p<0.001

Table 4. Comparison of pre- and post-test mean scores of information level of students'

Information test					
	Pre-test X±SD	Post-test X±SD	Test	Significance	Effect size (d)
Experimental group	51.23±3.8	69.73±8.8	10.254	.000**	2.729
Control group	50.62±5.5	58.37±8.5	.978	.020*	1.082
	t=.481 p=.440 d=0.129	t=7.972 p=.000** d=1.313			

X: mean, SD: standard deviation, t: independent sample t test, **p<0.001

Figure 2 presents a comparison of post-test mean scores between the EG and CG's regarding IV catheterization, IM injection, and the drug administration information test. The mean scores were higher for students in the EG. This indicates that web-based education not only enhanced the psychomotor skill development of the students but also significantly improved their knowledge level (Figure 2).

In Table 5, the effectiveness of web-based education along with independent variables in EG was assessed through Multivariate Analysis. The collective total effect of the independent variables (interest in having lessons online, use of the internet for learning psychomotor skills, and the belief in the effectiveness of web-based education) combined with the initiative of web-based education was found to be significant, with a cumulative effect size of 0.821. The individual effect sizes were determined as follows: for IV catheterization, partial eta squared was .699; for IM injection, partial eta squared was .768; and for the Information Test, partial eta squared was .598 (Table 5).

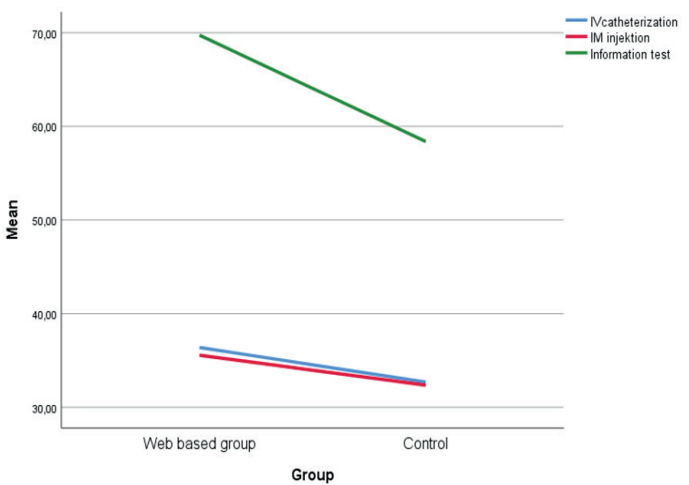


Figure 2. Comparison of students' IV catheterization, IM injection and drug applications information level post-test scores

Table 5. Evaluation of the effect of web-based education with jointly other independent variables by multivariate analysis

Tests of between-subjects effects ^a								
Source	Dependent variable	Type III sum of squares	Mean square	F	Sig.	Partial eta squared	Noncent. parameter	Observed power ^e
Corrected model	IV catheterization	474.879 ^b	118.720	4.137	.004	.163	16.548	.905
	IM injection	379.578 ^c	94.894	5.581	.000	.208	22.323	.972
	Information test	5006.731 ^d	1251.683	6.608	.000	.237	26.434	.989
Intercept	IV catheterization	5658.489	5658.489	197.182	.000	.699	197.182	1.000
	IM injection	4775.963	4775.963	280.870	.000	.768	280.870	1.000
	Information test	23911.593	23911.593	126.244	.000	.598	126.244	1.000
Status of requesting lessons to be processed online	IV catheterization	39.182	39.182	1.365	.246	.016	1.365	.211
	IM injection	32.183	32.183	1.893	.173	.022	1.893	.275
	Information test	709.418	709.418	3.745	.056	.042	3.745	.481
Status of using the internet to learn psychomotor skills	IV catheterization	.308	.308	.011	.918	.000	.011	.051
	IM injection	8.425	8.425	.495	.483	.006	.495	.107
	Information test	400.167	400.167	2.113	.150	.024	2.113	.301
Status of getting web-based education before	IV catheterization	443.075	443.075	15.440	.000	.154	15.440	.973
	IM injection	334.587	334.587	19.677	.000	.188	19.677	.992
	Information test	3766.010	3766.010	19.883	.000	.190	19.883	.993
The status of thinking that web-based education to be effective	IV catheterization	.043	.043	.002	.969	.000	.002	.050
	IM injection	22.394	22.394	1.317	.254	.015	1.317	.206
	Information test	52.433	52.433	.277	.600	.003	.277	.082

Wilks' Lambda: .179, F: 127.283, p=0.000, partial eta squared: .821, noncent. parameter: 381.850, observed power: 1.000;
a: weighted least squares regression - weighted by group, b: R squared=.163 (adjusted R squared=.124), c: R squared=.208 (adjusted R squared=.171), d: R squared=.237 (adjusted R squared=.201), e: computed using alpha=.05

Discussion

The Fundamentals of Nursing course is the first in which basic skills and practices are taught in nursing education. For the education to be effective, it is crucial that the methods, tools, and environment used in this course are adequately equipped. To bridge theory with practice and prepare students for the clinical setting, nursing students typically undergo training in professional skills laboratories. However, due to factors like the excessive number of students and a shortage of instructors, skill training often does not reach the desired level of development. Consequently, there is a demand for new technological methods that can enhance students' interests, learning experiences, and intellectual levels. This study assessed the effectiveness of web-based education in improving the conceptual knowledge level of first-year nursing students regarding drug administration and their skills in administering IM injections and IV catheterization. According to the research findings, the IV catheterization and IM injection skills of students in EG were significantly superior to those in CG. A wealth of research indicates that web-based learning methodologies significantly enhance the knowledge and practical abilities of nursing students. For example, Lu and colleagues analyzed the impact of online education on the proficiency of IM, noting that those trained online outperformed peers who relied solely on conventional teaching methods [13]. Similarly, in research conducted by Öz and Ordu, it was observed that nursing students subjected to online training on IM not only exhibited elevated knowledge levels but also superior practical skills compared to their counterparts. Additionally, integrating web-based tools like Kahoot was found to beneficially influence the learning outcomes for nursing students in this area [6]. Kim and Park found that web-based training improved the clinical skills of nursing students [14]. Furthermore, Márquez-Hernández and associates created an online platform aimed at the appraisal of nursing students' clinical abilities [15]. The application revealed that students accessing this tool showed exceptional performance in administering subcutaneous and intradermal injections, as well as in oxygen therapy, albeit IM injections were identified as a weaker area. The developers concluded that their web-based solution is a formidable approach for assessing clinical competencies [15]. These studies collectively validate the efficacy of online education in cultivating psychomotor skills within nursing education, echoing broader academic findings.

The students in EG demonstrated a significantly higher knowledge level about drug administration than those in CG. It is believed that the accessibility of videos, which students can watch anytime and anywhere, both in and out of the classroom, reinforces the subject matter, fosters better understanding, and effectively enhances the students' knowledge levels. Similar outcomes have been observed in the literature. Bilik et al. observed that nursing students engaged in online concept map training outperformed their counterparts in CG [16]. Similarly, Aydın and Dinç identified an enhancement in the arithmetic abilities and drug dosage calculations of students through web-based learning

[17]. Lu and team's investigation into nursing education revealed that online instructional support significantly boosted both the theoretical understanding and practical application of IM among students [13]. Moreover, Gerdprasert and associates' assessment of web-enhanced teaching methods for intrapartum nursing care demonstrated that students receiving this mode of instruction exhibited a notably superior grasp of knowledge and skills in intrapartum care compared to those in CG [18].

Furthermore, this study identified that independent variables, such as students' use of the internet for learning psychomotor skills and their belief in the effectiveness of web-based education, are instrumental in enhancing both psychomotor skills and knowledge levels in conjunction with web-based education. Given the widespread availability and ease of access to internet resources in today's era, the integration of web resources into nursing education should be expanded.

Web-based education is a learner-centered approach that fosters lifelong learning and provides a comprehensive array of services through information and communication technologies. It boasts the advantage of being self-directed and focused on the learner's needs [17]. The benefits of web-based education include user-friendliness, accessibility, efficient delivery of necessary instruction, the ability to access information anytime and anywhere, cost and time savings, and the opportunity for learners to progress at their own pace. It also encourages students to assume responsibility for their own learning, practice self-regulation, and develop the habit of "lifelong learning" [17-19]. Considering these positive contributions, it can be argued that incorporating these methods into nursing education will positively impact learning. Our research findings align with the principles of nursing as well as the outcomes of studies across different disciplines, suggesting that web-based instruction can serve as an effective educational method.

Limitations

This study has several limitations. First, conducting the study with a small group at a single organization in Turkey limits the generalizability of the findings; therefore, the results should be considered indicative rather than universally applicable. The second limitation is that students in CG were granted access to the web page only at the end of the study. Additionally, we were unable to gather students' opinions during the design phase of the web page due to the pandemic. In future research, it is recommended to solicit students' feedback on important aspects that may enhance engagement and effectiveness.

Conclusion

In conclusion, this study found that web-based education enhances the knowledge level of nursing students regarding IV catheterization, IM injections, and drug administration. Based on these findings, it is advised to utilize web resources effectively in teaching the psychomotor skills of first-year nursing students. It is suggested that web-based applications be made more accessible

to students and that learning environments on web pages be enriched with decision support systems and interactive videos to promote more engaging and dynamic learning experiences.

Given the current shortage of nurse educators, the high number of students, and the need for effective teaching methods, focusing on web-based education in clinical settings becomes crucial. This approach not only reduces the likelihood of student errors but also facilitates easier access to information. Future education interventions should pay greater attention to interactive learning methods and teacher support, emphasizing the importance of enhancing the overall learning experience for nursing students.

Conflict of Interests

The authors declare that there is no conflict of interest in the study.

Financial Disclosure

This research was supported by the İnönü University Scientific Research Project Unit. We would like to thank İnönü University Scientific Research Project Unit for their support. Funding Number: TSA-2021-2407.

Ethical Approval

Authorization for the study (2021/1454) was secured from the Scientific Research and Publication Ethics Committee of Health Sciences at İnönü University. Consent was also obtained from the dean of the faculty. Participants were thoroughly briefed about the study's aims, reassured about their freedom to disengage at any point, and their consent, whether in writing or orally, was recorded.

References

1. Wolf AB. The impact of web-based video lectures on learning in nursing education: an integrative review. *Nurs Educ Perspect.* 2018;39:E16-20.
2. Bazrafkan L, Najafi Kalyani M. Nursing students experiences of clinical education: a qualitative study. *Invest Educ Enferm* 2018;36.doi: 10.17533/udea.iee.v36n3e04
3. Alshawish E, El-Banna MM, Alrimawi I. Comparison of blended versus traditional classrooms among undergraduate nursing students: a quasi-experimental study. *Nurse Educ Today.* 2021;106:105049.
4. Razak RA, Hua KB. Self regulated learning for developing nursing skills via web-based. *MOJES: Malaysian Online Journal of Educational Sciences* 2018; 1(1): 43-54. <https://files.eric.ed.gov/fulltext/EJ1086255.pdf>
5. McDonald EW, Boulton JL, Davis JL. E-learning and nursing assessment skills and knowledge - an integrative review. *Nurse Educ Today.* 2018;66:166-74.
6. Öz GÖ, Ordu Y. The effects of web based education and Kahoot usage in evaluation of the knowledge and skills regarding intramuscular injection among nursing students. *Nurse Educ Today.* 2021;103:104910.
7. 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.* 2020;13:1961-8.
8. Cohen J. Statistical power analysis for the behavioral sciences. 2nd edition. Routledge, New York, 1988.
9. Ay FA. Basic concepts and skills in health practice improved and updated. 7th edition. Nobel Medical Bookstores Press, İstanbul, 2019. (in Turkish).
10. Lowry-Lehnen T. Administering intramuscular injection guidelines. In: *Practice Nursing : Clinical Guidelines and Procedures in Practice.* 1st edition. International Medical Publisher, United States, 2018;96-8.
11. Kaşıkçı MK, Palandöken EA. Drug application methods. In: *Basic Nursing: Fundamentals, Concepts, Principles, Practices.* 1st edition. İstanbul Medical Bookstore, İstanbul, 2021. (in Turkish).
12. Schuster C, Stahl B, Murray C, et al. Development and testing of a short peripheral intravenous catheter insertion skills checklist. *JAVA.* 2016;21:196-204.
13. Lu DF, Lin ZC, Li YJ. Effects of a web-based course on nursing skills and knowledge learning. *J Nurs Educ.* 2009;48:70-7.
14. Kim JH, Park H. Effects of smartphone-based mobile learning in nursing education: a systematic review and meta-analysis. *Asian Nurs Res (Korean Soc Nurs Sci).* 2019;13:20-9.
15. Marquez-Hernandez VV, Gutierrez-Puertas L, Granados-Gamez G, et al. Development of a web-based tool to evaluate competences of nursing students through the assessment of their clinical skills. *Nurse Educ Today.* 2019;73:1-6.
16. Bilik Ö, Kankaya EA, Deveci Z. Effects of web-based concept mapping education on students' concept mapping and critical thinking skills: a double blind, randomized, controlled study. *Nurse Educ Today.* 2020;86:104312.
17. Karabağ Aydın A, Dinç L. Effects of web-based instruction on nursing students' arithmetical and drug dosage calculation skills. *Comput Inform Nurs.* 2017;35:262-9.
18. Gerdprasert S, Pruksacheva T, Panijpan B, Ruenwongsa P. An interactive web-based learning unit to facilitate and improve intrapartum nursing care of nursing students. *Nurse Educ Today.* 2011;31:531-5.
19. Steinke EE, Barnason S, Mosack V, Hill TJ. Baccalaureate nursing students' application of social-cognitive sexual counseling for cardiovascular patients: a web-based educational intervention. *Nurse Educ Today.* 2016;44:43-50.