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Research

The effectiveness of simulation game on nursing students' surgical nursing knowledge—a quasi-experimental study

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ABSTRACT

Student nurses need diverse learning experiences throughout their studies to learn surgical nursing. Interactive virtual simulations for hybrid education in the COVID-19 postpandemic era provide new opportunities to learn knowledge through practical patient scenarios. The aim of this study was to evaluate the effectiveness of a simulation game on nursing students' surgical nursing knowledge. A quasi-experimental design was used, including a pre- and post-test and experimental (simulation game) group ($n = 140$) and a control (theoretical self-study material) group ($n = 136$). The level of surgical nursing knowledge was assessed with the surgical nursing knowledge (SNK) test. The data were collected in three universities of applied sciences in Finland. Both groups had better surgical nursing knowledge after the intervention than before. The change of surgical nursing knowledge was greater in the experimental group than in the control group. The simulation game was an effective approach to learning surgical knowledge. Simulation games as an interactive and motivating tool may add value in hybrid education by combining theoretical pre- and postoperative nursing care content and practical skills.

Introduction

Student nurses need diverse learning experiences throughout their studies to learn surgical nursing. Surgical nursing refers here to preoperative and postoperative nursing care taking place in inpatient surgical wards, excluding the intraoperative phase (Andreasen et al., 2022). In Finland, where the current study was conducted, the concept of perioperative nursing is understood as nursing including preoperative, intraoperative, and postoperative theatre nursing and anesthetic nursing. Surgical nursing, on the other hand, is implemented in surgical wards before and after the nursing takes place in the operating ward/unit. One of the major challenges for surgical nursing is to predict patient deterioration often in time-constrained situations that demand complex decision-making abilities (Marshall et al., 2022; Verrillo et al., 2019). Hybrid education has become the new normal in the COVID-19 postpandemic era (Shorey et al., 2022). However, during the COVID-19 pandemic, one of the challenges in online learning for nursing students was combining theoretical knowledge with practice; thus, the development of clinical skills and competencies was perceived as insufficient (Shorey et al., 2022). Therefore, online teaching must include theoretical pre- and postoperative content and practical skills training to prepare nursing students for surgical clinical placements (Andreasen et al., 2022; Hou et al., 2022; Tseng et al., 2022) and simulation games with realistic surgical patient scenarios that utilize interactive gaming elements are suitable for this purpose (Koivisto et al., 2023).

A recent scoping review (Andreasen et al., 2022) revealed that in nursing education, human patient simulations, virtual simulations, web-based learning, and case studies have been used to teach pre- and postoperative content, including patient safety, pre- and postoperative nursing assessment, medication assessment and administration, care for patient emotional needs, and team communication. Interactive remote education software tools, such as virtual simulations and simulation games, are effective learning methods (Havola et al., 2021; Sen et al., 2022). Havola et al. (2021) revealed that clinical reasoning skills systematically improved when measured at three time points when using a desktop simulation game and a virtual

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reality game. Sen et al. (2022) revealed that a mobile virtual reality (MVR) application improved learning outcomes of nursing students practicing their surgical skills when compared with conventional learning methods. Learning outcomes of MVR included learning retention, increased confidence, and reduced anxiety. On the other hand, no statistically significant difference were found between the post-test 1 and post-test 2 in preoperative and postoperative care knowledge levels between web-based and traditional education group measured knowledge test (Edeer et al., 2019). The web-based education included for example text, images, flowcharts, tables, case studies, and videos. Although effective learning outcomes are not always achieved, Shorey et al. (2022) state in their systematic review and meta-synthesis that interactive remote education software tools are an effective means to reduce disengagement and digital fatigue, which nursing students have experienced in recent years. However, it should be noted that online environments with a lot of visual elements can also cause cognitive load for students and thus, digital fatigue should be considered in teaching.

Andreasen et al. (2022) found in their scoping review that pre- and postoperative care learning outcomes include knowledge, skills, clinical reasoning, experiences about learning activity, and stress and anxiety. However, research evidence is limited on the effectiveness of simulation games with game elements for nursing students' surgical nursing knowledge. Simulation games differ from virtual simulations in that they use elements familiar to entertainment games, such as interactive 3D environments, high-quality animations, graphics, progress tracking and scores, and visual and text-based feedback, to enhance learning (Koivisto et al., 2018). On the other hand, nursing simulation games differ from entertainment simulation games in that they have clear learning objectives corresponding to the curriculum. Research is needed such that students can be better prepared for clinical practice. Additionally, it is important to acquire information on the effectiveness of simulation games for surgical nursing knowledge to implement effective online learning methods.

The aim of this study was to evaluate the effectiveness of a simulation game on nursing students' surgical nursing knowledge. The research questions were:

1. How is students' surgical nursing knowledge in the experimental and control groups before and after the intervention?
2. How has surgical nursing knowledge changed in the experimental and control groups?

Methods

Research Design

Quasi-experimental design including pre- and post-test and experimental and control group was utilized. Although the students were randomized into an experimental and a control group, as in an experimental design (Polit & Beck, 2017), the researchers consider this study to be quasi-experimental, because the randomization to the groups was conducted in predetermined study groups and not in the entire population and it did not have blinding of participants. Experimental educational research is still rare in nursing even though especially between-subjects designs are adequate to test the efficacy of interventions (Watson et al., 2023). This study is one attempt to fill this gap. The Transparent Reporting of Evaluations with Nonrandomized Designs (TREND) statement was used to reduce the risk of deficient reporting (Des Jarlais et al., 2004).

Setting and Participants

This study was conducted in three universities of applied sciences (UAS) in Finland as a part of a surgical nursing course between March 1, 2018, and May 31, 2019. The aim of surgical nursing courses is for students to master the basic knowledge and skills related to preoperative and postoperative care. The surgical nursing requirements of the Finnish curriculum include the ability to apply knowledge of different phases of perioperative nursing care and the ability to respond to patients' needs by planning, implementing, and assessing appropriate individual nursing care (Kajander-Unkuri et al., 2020).

Purposive sampling was used to recruit nursing students (Polit & Beck, 2017). The total population of students participating in the surgical nursing courses in three UAS was at the time of data collection about 800. Around 400 students played the simulation game as a part of the course's learning activities, and they were offered participation in the study. Recruitment was carried out by researchers and contact teachers at the beginning of each course during one and a half year of data collection. The students were at the same stage of study in all UASs from the perspective of the content of their studies. Surgical nursing course content was equivalent for all students before the intervention and consisted of lectures (e.g., pre- and postoperative nursing, intravenous fluid therapy, blood transfusion), case exercises, and online theoretical self-study.

A total of 385 students participated in the surgical nursing course at the time of the study across three UASs, of which 276 (70%) voluntarily participated in the study. The students were randomized into an experimental group and a control group. Randomization was conducted as follows: from the student's name lists, every other student was assigned to the experimental group and every other student to the control group. The group of the first student on the lists was drawn. Altogether 276 nursing students participated in the 1-week intervention, including 140 students in the experimental and 136 in the control group. Both groups had students from all student classes participating in the study (Fig. 1).

Intervention

During the 1-week intervention, nursing students in the experimental group played the simulation game and the students in the control group studied the provided theoretical self-study material. The intervention week began with filling out an electronic questionnaire including the surgical nursing knowledge (SNK) test (pretest) and background information. At the end of the intervention week, the participants filled in SNK test again (post-test).

The self-study material was the same material that was used for the scenarios and the SNK test (Table 2). Each UAS had a contact teacher who delivered the intervention supported by the research group. The students worked independently during the intervention week. Students played a three-dimensional (3D) simulation game on a desktop computer. The game has been developed with the Unity development platform in a learning environment development project in a Finnish UAS (Koivisto et al., 2018). The game environment was a 3D hospital ward, and the game had a 3D virtual patient who was a 70-year-old male. In the game, authenticity and realism were achieved by incorporating graphics of authentic equipment and animations indicating a patient's authentic reactions, gestures, and facial expressions. Action points in the game included interviewing the patient, assessing the patient's clinical states, and implementing nursing interventions (Koivisto et al., 2023) (Fig. 2). The game has previously been used in several studies indicating, for example, increased learning outcomes in clinical reasoning skills and good user experience (Havola et al., 2021; Koivisto et al., 2016; Mäkinen et al., 2023).

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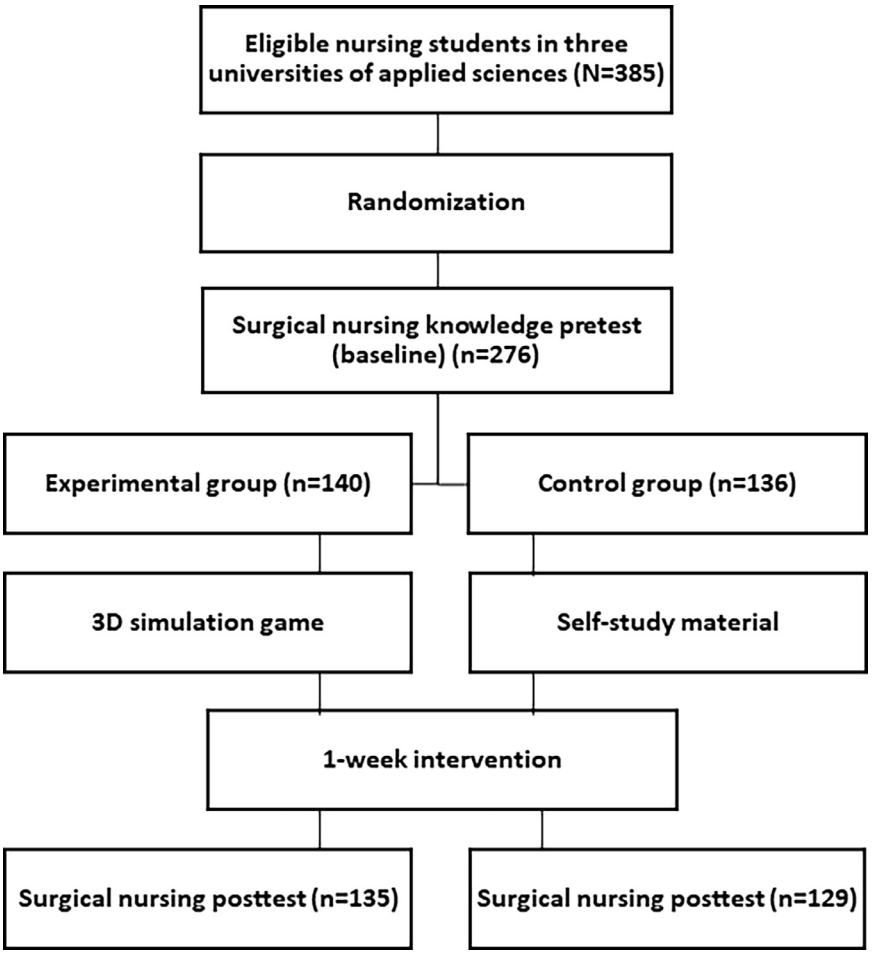

Fig. 1. Flowchart of quasi-experimental research design.

Students played five surgical patient scenarios with content that corresponded to curriculum objectives and to the content of surgical nursing courses (pre- and postoperative patient care) (Table 1). The number of played scenarios and the playing time were not limited but it was instructed that each of the five surgical patient scenarios had to be played at least once. The contents of the scenarios were developed based on research articles (Table 2). Students in the control group self-studied the same content by reading the theoretical material.

Data Collection

Data were collected using an electronic questionnaire. The level of surgical nursing knowledge was assessed by pre- and post-tests with the surgical nursing knowledge (SNK) test. The SNK test was developed for this study and had not been previously validated. The test was developed for teaching to objectively measure the students' knowledge of the course contents. The pretest was completed before the intervention and the post-test after the intervention. The

Fig. 2. Screenshot of the simulation game.

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Table 1
Scenarios in the simulation game.

Scenario	Patient description	Learning contents
Blood transfusion of surgical patient	A 70-year-old man with hypertension and hyper cholesterol. Transurethral resection of the prostate (TURP) was done yesterday. Today patient has low hemoglobin (84 g/L). The doctor has ordered a blood transfusion. The patient is tired, and he has pain in the wound area.	Perform blood transfusion in a patient-safe manner. Reconstitute the blood product for the patient. Monitor the patient's well-being during transfusion. Identify the symptoms of anaphylaxis.
Postoperative hemorrhage and hypovolemia	A 70-year-old man with hypertension. Intestinal resection has been done under general anesthesia today. The patient has been in the ward for 2 hours. The patient has IV infusion, catheter, and epidural pain medication. There is no discharge from the wound dressings.	Assess the patient's postoperative status using the ABCDE approach. Recognize postoperative complications. Identify the NEWS criteria. Implement nursing interventions.
Preoperative assessment	A 70-year-old man, with osteoarthritis in the left knee, DM2, and previously heavy alcohol use. The patient has come to the surgical ward for the interview and preparations for the day of surgery.	Assess the patient's preoperative status using the ABCDE approach. Identify the special characteristics of the care of the emergency patient. Identify signs of infection. Prepare patient for surgery.
Postoperative assessment	A 70-year-old man with hypertension, diabetes mellitus grade two and ASO. Bypass surgery to the lower limb was done yesterday.	Assess the patient's postoperative status using the ABCDE approach. Recognize the symptoms of hypovolemia. Identify the NEWS criteria. Implement nursing interventions.
Pain management of surgical patient	A 70-year-old man. Laparoscopic removal of the gallbladder has been done under general anesthesia today. The patient has a catheter and there is no discharge from the wound dressings. The patient rings the alarm bell.	Assess the patient's postoperative status using the ABCDE approach. Identify the NEWS criteria. Assess the patient's pain. Implement pain management.

knowledge test measured the students' preoperative and postoperative knowledge. The electronic questionnaire also included demographic questions (educational background, work experience in social and health services, and previous gaming activity). Further, it included self-evaluation of phases of clinical reasoning (CR) skills (collecting information, processing information, identifying problems, establishing goals, taking actions, and evaluating outcomes) (Koivisto et al., 2016; Levett-Jones et al., 2010). The students' playing time and scores were stored in the simulation game database. These so-called game metrics included the following quantitative measures: the mean score and the mean playing time of all playthroughs by all students. Playthroughs refer here to all scenarios played by all students (Havola et al., 2021; Koivisto et al., 2023). The SNK test examining students' knowledge in preoperative and postoperative care was developed for this study by experts in pedagogy and surgical nursing based on the research articles (Table 2). The SNK test consisted of six subscales and 60 items. The items were rated on a scale right or wrong. The maximum score was 60.

Table 2
References for the scenarios and surgical nursing knowledge test.

Reference
Finnish Current Care Guideline 2014. Leikkausta edeltävä arviointi. [Assessment before surgery]
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Hynninen, M., Vikatmaa, L., & Vuorisalo, S. 2016. Verisuonikirurgisen potilaan arviointi ja hoito teho-osastolla. [Assessment and treatment of the vascular surgery patient in the intensive care unit.] In M. Venermo, & A. Ahlbäck (Eds.). Verisuonikirurgian käsikirja. [Handbook of vascular surgery.] (pp. 47–50).
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Suominen, E., Peltomaa, M., & Leppänen, I. 2014. National Early Warning Score* (NEWS auttaa sairaanhoitajaa tunnistamaan ajoissa kriittisesti sairaan potilaan vuodeosastolla). [National Early Warning Score, NEWS give assistance the nurse to identify the critically ill patient in the ward at the right time.] Spirium, 49(3), 10–12.

Data Analysis

Descriptive statistics were used to present characteristics of the data. Means of surgical nursing knowledge were compared using two-way ANOVA with an interaction term of group and time together with adjusting variables (educational background, work experience in social and health services, previous gaming activity [gaming refers here how much students played nondigital games, digital games or educational games in the last year], self-evaluated measures of phases of the following CR skills: collecting information, processing information, identifying problems, establishing goals, taking actions, and evaluating outcomes). Changes and differences of means were estimated together with p values, standard errors, and confidence intervals. Analyses were performed with statistical software SAS version 9.4.

Ethical Considerations

This research was designed according to established ethical guidelines (Finnish National Board on Research Integrity, 2019). Permission to conduct the research was granted by the directors of the higher education organizations. Ethical approval was obtained from the Ethics Committee of (anonymized) Higher Education Institution.

Results

Over half of the students in the experimental group (59.6%) and the control group (61.1%) had a high school as their background education (Table 3). In both groups, over half of the students had less than a year of work experience in social and health services. The students in both groups had the most previous gaming activity from

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Table 3
Participants background variable ($N = 276$).

	Experimental group ($n = 140$)		Control group ($n = 136$)	
	n	%	*n*	%
Educational background				
Vocational upper secondary education, practical nurse	42	40.4	35	38.9
High school	62	59.6	55	61.1
Missing 82				
Work experience in social and health services				
<1 year	77	55.0	73	53.9
1–5 years	44	31.4	48	35.3
6–10 years	10	7.1	10	7.4
>10 years	9	6.4	5	3.7
Previous gaming activity				
Nondigital games				
Daily	1	0.7	0	0
Weekly	11	4.0	5	3.8
About once a month	30	21.6	24	18.1
Less than once a month	84	60.4	86	64.7
Not at all	13	9.4	18	13.5
Missing 4				
Digital games				
Daily	15	10.7	10	7.5
Weekly	29	20.7	27	20.3
About once a month	17	12.1	19	14.3
Less than once a month	44	31.4	47	35.3
Not at all	35	25.0	30	22.6
Missing 3				
Educational games				
Daily	1	0.7	1	0.8
Weekly	5	3.6	5	3.7
About once a month	8	5.8	14	10.5
Less than once a month	77	55.4	62	46.3
Not at all	48	34.5	52	38.8
Missing 3				

digital gaming. There were no significant differences in the demographic information between groups. The mean score was 75.7 (SD 9.89) and the mean playing time was 4.6 min (SD 96.0) of all playthroughs by all players.

Both groups had better surgical nursing knowledge after the intervention than before. The knowledge of both groups was greatest in the subarea SNK 3 "Preoperative assessment of an orthopedic surgery patient" before and after the intervention. The knowledge for the experimental group was poorest in the subarea SNK4 "Postoperative assessment of peripheral artery bypass surgery patient" before the intervention but after the intervention in subarea SNK1 "Blood transfusion of surgical patient." The control group had poorest knowledge in the subareas SNK1 "Blood transfusion of surgical patient" and SNK5 "Pain management of surgical patient" both before and after the intervention (Table 4). Before the intervention, the control group had significantly better knowledge than experimental group in subarea SNK2 "Postoperative hemorrhage and hypovolemia" ($p < .0001$). After the intervention, the control group knowledge was significantly better in subareas SNK1 "Blood transfusion of surgical patient" ($p = .04$), SNK3 "Preoperative assessment of an orthopedic surgery patient" ($p < .0001$), and SNK6 "Identification of disorders of vital signs according to NEWS in postoperative nursing" ($p = .040$) (Table 5).

The change of surgical nursing knowledge was greater in the experimental group than in the control group (Table 4). In the experimental group, there was a statistically significant change for the greater knowledge in total SNK score ($p = .002$), subareas SNK 2 "Postoperative hemorrhage and hypovolemia" ($p < .0001$), SNK 3 "Preoperative assessment of an orthopedic surgery patient" ($p < .0001$) and SNK 4 "Postoperative assessment peripheral artery bypass surgery patient" ($p = .0003$) (Table 5). On the contrary, there was a statistically significant change for the poorer knowledge in subareas SNK 1 "Blood transfusion of surgical patient" ($p = .02$) and SNK 6 "Identification of disorders of vital signs according to NEWS in postoperative nursing" ($p < .0001$). In the control group, there was a statistically significant change for the better knowledge only in subarea SNK 3 "Preoperative assessment of an orthopedic surgery patient" ($p = .02$) and poorer knowledge in subarea SNK 6 "Identification of disorders of vital signs according to NEWS in postoperative nursing" ($p = .01$).

Discussion

The aim of the present study was to examine the effectiveness of a simulation game on nursing students' surgical nursing knowledge. A previous study noted the challenges in online learning of combining theoretical knowledge with practice and suggested using more interactive software tools in education (Shorey et al., 2022). In this study, an interactive simulation game was used to provide surgical nursing knowledge through practical patient scenarios. The result showed that both groups had better surgical nursing knowledge after the intervention than before. Although the knowledge of the students who played the simulation game was poorer than those who read the theoretical self-study material before and after the intervention, the change was greater for the students who played the simulation game. Thus, playing the game is an effective means of acquiring surgical nursing knowledge. The results are somewhat different than those of Edeer et al. (2019) who were unable to demonstrate that web-based training based on text, images, and videos is effective in providing preoperative and postoperative care knowledge. Possible explanation for this result in this study could be that simulation games combining virtual simulation and game elements provide surgical nursing knowledge in an interactive manner (Chang et al., 2020; Koivisto et al., 2018). Another possible explanation is that students

Table 4
Nursing students' surgical nursing knowledge.

Surgical nursing knowledge test score	Experimental group						Control group					
	Pretest			Post-test*			Pretest			Post-test*		
	N	Mean	Std Dev	*N*	Mean	Std Dev	*N*	Mean	Std Dev	*N*	Mean	Std Dev
SNK total[a]	140	40.8	3.66	135	43.2	3.61	136	43.4	5.01	129	43.6	4.62
SNK 1 blood transfusion of surgical patient[b]	140	6.7	1.18	135	6.2	1.17	136	6.7	1.43	129	6.7	1.36
SNK 2 postoperative hemorrhage and hypovolemia[b]	140	6.3	1.3	135	7.8	1.00	136	7.3	1.27	129	7.5	1.31
SNK3 preoperative assessment of an orthopedic surgery patient[b]	140	7.6	1.12	135	8.7	1.05	136	8.4	1.42	129	8.8	1.18
SNK4 postoperative assessment of peripheral artery bypass surgery patient[b]	140	6.2	1.30	135	7.3	1.43	136	6.9	1.51	129	7.1	1.54
SNK5 pain management of surgical patient[b]	140	6.6	1.4	135	6.8	1.55	136	6.7	1.60	129	6.7	1.55
SNK6 identification of disorders of vital signs according to NEWS in post-operative nursing[b]	140	7.3	1.147	135	6.4	0.99	136	7.4	1.24	129	6.8	1.22

[a] Sixty items.
[b] Ten items.
* The reasons for students' attrition could be that they did not want or remembered to answer the post-test after playing, or they did not play the game after answering the pretest and therefore did not answer the post-test.

can apply their knowledge on patient cases in simulation games, which can strengthen knowledge acquisition (Koivisto et al., 2016).

In this study, nursing students' surgical nursing knowledge varied between subareas. For both groups, knowledge was the greatest in subarea "Preoperative assessment of an orthopedic surgery patient." A possible explanation for this may be that the learning content of preoperative nursing is similar for all patient groups, thus learning the subject area involves considerable repetition in surgical nursing courses. When looking at the change by subarea, both groups had poorer scores after the intervention than before in subareas "Blood transfusion of surgical patient" and "NEWS Identification of disorders of vital signs according to NEWS in postoperative nursing." This was unexpected, as for the blood transfusion there is a clear protocol based on the Finnish Red Cross handbook for blood transfusion. On the other hand, this result is understandable as the subject is difficult and challenging for students. Regarding NEWS, result may be due by the fact that even though The National Early Warning Score (NEWS) assessment tool is simple and rapid to complete (Green et al., 2018),

Table 5
Changes and differences in surgical nursing knowledge.

	Group	Time	Estimate of change/difference[a]	Standard error	*p*[b]	95% CI lower	95% CI upper
SNK total score							
	Experimental vs control	Pre	−2.66	.59	<.0001	−4.17	−1.15
	Experimental vs control	Post	-.99	.61	.36	−2.56	.58
	Experimental	Post vs pre	2.02	.56	.002	.58	3.47
	Control	Post vs pre	.35	.61	.94	−1.22	1.93
SNK 1 score							
	Experimental vs control	Pre	−.09	.19	.96	−.58	.43
	Experimental vs control	Post	−.53	.20	.04	−1.04	−.02
	Experimental	Post vs pre	−.52	.18	.02	−.99	−.06
	Control	Post vs pre	−.08	.20	.98	−.59	.51
SNK 2 score							
	Experimental vs control	Pre	−.80	.18	<.0001	−1.27	−.33
	Experimental vs control	Post	.24	.19	.59	−.25	.72
	Experimental	Post vs pre	1.29	.17	<.0001	.85	1.74
	Control	Post vs pre	.26	.19	.53	−.23	.74
SNK 3 score							
	Experimental vs control	Pre	−.84	.16	<.0001	−1.27	−.42
	Experimental vs control	Post	−.27	.17	.39	−.71	.17
	Experimental	Post vs pre	1.09	.16	<.0001	.68	1.49
	Control	Post vs pre	.51	.17	.02	.07	.96
SNK 4 score							
	Experimental vs control	Pre	−.49	.23	.14	−1.1	.10
	Experimental vs control	Post	.17	.24	.89	−.44	.78
	Experimental	Post vs pre	.89	.22	.0003	.33	1.45
	Control	Post vs pre	.24	.24	.75	−.38	.85
SNK 5 score							
	Experimental vs control	Pre	−.37	.23	.39	−.98	.24
	Experimental vs control	Post	−.11	.24	.97	−.73	.52
	Experimental	Post vs pre	.25	.22	.69	−.33	.83
	Control	Post vs pre	−.02	.24	1.00	−.65	.61
SNK 6 score							
	Experimental vs control	Pre	−.07	.18	.98	−.53	.38
	Experimental vs control	Post	−.49	.18	.04	−.96	−.02
	Experimental	Post vs pre	−.97	.17	<.0001	−1.40	−.53
	Control	Post vs pre	−.56	.18	.01	−1.03	−.08

[a] Estimates of ad hoc *t* testing are adjusted by educational background, work experience in social and health services, previous gaming activity and collecting information, processing information, identifying problems, establishing goals, taking actions, and evaluating outcomes. Multiple group comparisons are adjusted by Tukey's correction.
[b] $p < .05$ was considered significant.

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recognizing deterioration of the patient's clinical condition is challenging for students at the beginning of their studies when they still have minimal experience in practical patient care.

The implementation of the intervention was successful because the students received practical instructions about participating in the intervention verbally and in writing. In addition, the simulation game was easily accessible in a web browser and logging into the game was easy. Almost all students managed to play without any technical problems. Those who encountered problems received help from technical support and researchers.

Limitations

The strength of this study was that learning effectiveness was investigated with a quasi-experimental design with an experimental group and a control group and a pretest and a post-test. In addition, the groups were similar in terms of background information and outcomes were measured in the same way. However, the study has some limitations. First, the data were collected in only one country and only in three UASs, which may limit the generalizability of the results. Second, the SNK test was developed for this study and has not been previously used. Third, the patient descriptions do not represent a diverse sample of individuals but only a 70-year-old male patient. These results therefore should be interpreted with caution. However, the content of the knowledge test corresponded to the scenarios of the simulation game and the theoretical self-study material were based on the same sources. Notwithstanding these strengths and limitations, the study suggests that simulation games that combine theoretical pre- and postoperative nursing care content and practical skills (Andreasen et al., 2022; Hou et al., 2022; Tseng et al., 2022) can be used along other learning methods to increase nursing students' surgical nursing knowledge and thus prepare students for challenging surgical nursing settings and patient situations.

Conclusion

This study confirms the effectiveness of a simulation game on nursing students' surgical nursing knowledge. The results revealed that knowledge was significantly better after the intervention than before for nursing students who played the simulation game. Therefore, simulation games may add value in hybrid online education by offering possibilities to acquire theoretical knowledge through practical patient scenarios in an interactive, motivating, and effective way. However, more research is needed about the effectiveness of simulation games and further research should be conducted with larger sample sizes in multiple international settings. Another venue for research could be investigating students' surgical nursing knowledge by analyzing data stored in simulation games to acquire more detailed information about students' knowledge.

Declaration of Competing Interest

The authors declare that they have no conflict of interest.

Author Contributions

Conception and design: JMK, TB, KR, EH, acquisition of data: JMK, KR, TB, analysis of data: JMK, JE, drafting the manuscript: JMK, TB, KR, JE, revising manuscript critically: JMK, TB, KR, JE, EH.

Author Statement

This manuscript or a very similar manuscript has not been published, nor is under consideration by any other journal.

Data Statement

The research data remain confidential and will not be shared to ensure participants' anonymity.

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