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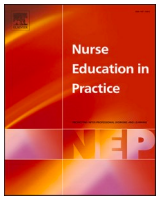

The effect of flipped learning on nursing students' Asepsis knowledge and learning skills: A randomized controlled study☆

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ABSTRACT

Aim: This study was conducted to evaluate the effect of the flipped learning model on nursing students' asepsis knowledge and learning skills.
Background: The flipped learning model enables students to pursue their learning with online support whenever and wherever they want. Students have the responsibility for their learning activities. The flipped learning model is an effective method to improve nursing students' knowledge and skills related to the principles of asepsis with online innovative approaches.
Design: This study has a pre-test post-test open-label, randomized controlled design.
Method: The study sample consisted of 107 first-year nursing students randomized into experimental (n = 53) and control (n = 54) groups. The experimental group students were trained utilizing the flipped learning model. The data were collected through the "Descriptive Characteristics Form of Nursing Students ", the "Principles of Asepsis Knowledge Test" and the " Self-directed Learning Skills Scale".
Results: It was determined that the post-test knowledge score of the experimental group was statistically significantly higher (p=0.000) than the control group and the median of the retention test knowledge score was statistically significantly higher (p=0.000) than the control group. There was a statistically significant increase (p<0.05) in the median score of the self-directed learning skills scale "self-control" sub-dimension of the experimental group.
Conclusion: Flipped learning increased nursing students' knowledge related to the principles of asepsis and enabled them to take responsibility for learning. This model had a positive effect on students' higher order thinking skills such as critical organization and decision making. It is recommended to use the flipped learning within the scope of nursing education and especially in gaining basic skills.
Tweetable abstract: A success in today's education; flipped learning

1. Introduction

Nursing education is a training process aiming to provide both theoretical and psychomotor skills (Aksoy and Paslı Gurdoğan, 2022). With this training process, students are expected to develop psychomotor skills both at the level of knowledge and ability to practice (Moran et al., 2021). In this context, the implementation of a clear, memorable, technological and visually rich teaching method in the nursing education process is of great importance for academic success (Chen et al., 2020; O'Connor, 2023).

In the first year of their education, nursing students encounter a curriculum providing basic knowledge and skills (Hidalgo-Blanco et al., 2021; Lukić et al., 2023). One of the primary topics of this process is infection control, which is indispensable for healthcare (Bouchoucha et al., 2021; Chang et al., 2023). Improving knowledge and skills about infection control, especially the concept of asepsis, is a key for nursing students (Serpici et al., 2023). It is important to understand the concept of asepsis well and to improve psychomotor skills for asepsis practices during student years (Bouchoucha et al., 2021). These skills gained during this period are effective in preventing healthcare-associated infections and patient safety in care services (Chang et al., 2023). Both the theoretical infrastructure and the application dimension of the concept of asepsis should be reinforced with permanent teaching methods (Çonoğlu et al., 2022; O'Connor, 2023).

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Today, several methods such as artificial intelligence supported trainings, simulation laboratories, gamified educational videos uploaded to smartphones, case-based learning, problem-based learning and blended learning styles are taking their place in education (Zhang et al., 2022; Zugai et al., 2022). This is because our current students have grown up in a rapidly evolving digital world. In order to realize a comprehensible education for this generation, it is necessary to leave the traditional education model and switch to an education model reinforced with digital materials (Rosa-Castillo et al., 2022). Therefore, the educational method should be composed of more memorable and fun methods providing convenience in concepts that are difficult to learn. One of these methods used today is the flipped learning model (Oğurlu, 2023; Özkan and Demirbağ, 2023).

The flipped learning model offers students and instructors a non-traditional teaching opportunity. It is based on the principle of integrating in-class activities outside the classroom and out-of-class teaching activities inside the classroom (Oğurlu, 2023). In the flipped learning approach, students receive study materials before class and prepare for the lesson, then they share basic knowledge in the classroom and improve the concepts taught according to the determined goals (Hwang et al., 2021; Qutob, 2022). Preparation before the lesson is also important for effective use of class time. The student is at the center of this learning method and the student assumes individual learning responsibility (Özkan and Demirbağ, 2023). Studies in the literature have confirmed that the flipped learning model as an active learning strategy is associated with improved student performance, reduced failure rate and better learning achievements (Bıyık Bayram, 2019; Çonoğlu et al., 2022; Dehghanzadeh and Jafaraghaee, 2018; Hwang et al., 2021). In the literature, there are studies examining flipped learning model with nursing students and concluded that the model was effective in improving students' problem solving, critical thinking, and communication skills (Dehghanzadeh and Jafaraghaee, 2018; Hwang et al., 2021; Ratta, 2015; Yacout and Shosha, 2016).

That the flipped learning modal has student-centered nature also brings about self-directed learning. Self-directed learning allows students to take responsibility for learning, plan, realize learning situations and evaluate their learning (Aşkın Tekkol and Demirel, 2018). Students who can manage their own learning process are individuals who can think at a high level and know how to access information. Students' willingness and openness to learn make them active in lifelong learning (Hwang et al., 2021; Aşkın Tekkol and Demirel, 2018). Determining self-directed learning skills of nursing students, as of all university students, will be guiding for both the academic performance of the students and the instructors.

In this study, it was aimed to evaluate the effect of the flipped learning model on the concept of asepsis and learning skills of nursing students. With the flipped learning, it is aimed to continue teaching outside the classroom. Increasing awareness by putting the student at the center, transferring the relevant learning to behavior, and repetitive lesson studies with professionally prepared materials are the other goals.

2. Methods

2.1. Design

This study has a randomized controlled open-label pretest-posttest design. The study aimed to evaluate the effect of flipped learning method on nursing students' asepsis knowledge and learning skills.

2.2. Research setting

The study was conducted in the fall semester of the 2023–2024 academic year in the nursing department of the faculty of health sciences of a university. In the relevant department, the Fundamentals of Nursing course, which is the basis of the nursing profession, is offered in two semesters. In the first semester of the first year, 3 hours of theory and 4 hours of practice, followed by 4 hours of theory and 16 hours of practice in the second semester of the first year. Within the scope of practices, students reinforce what they have learned with laboratory and clinic. Within the scope of the course, after the theoretical lecture by the instructor, laboratory applications, videos, puzzle method, word cloud, etc. are utilized to improve the psychomotor skills of the students.

2.3. Participants

The study was conducted from November 08, 2023 to December 20, 2023. The population of the study consisted of 130 students enrolled in the first-year Nursing Principles-I course in the nursing department of the faculty of health sciences of a university. The sample consisted of 107 students who fulfilled the inclusion criteria of the study and participated in the pre-test (experimental group 53, control group 54 students) (Fig. 1).

The inclusion criteria were as follows: attending the Fundamentals of Nursing course for the first time, having a phone or computer with internet access, and volunteering to participate in the study. The exclusion criteria were as follows: having taken the Fundamentals of Nursing course before, not attending the post-test, not attending the courses and not volunteering to participate in the study.

The OpenEpi program was used to determine the sample size of the population consisting of 130 students. When the sample calculation was made with the OpenEpi sample calculation program used in the computer environment with a 50% observation rate, 5% standard deviation and 99.99% power range, it was planned that 120 students would constitute the study sample. (https://www.openepi.com/SampleSize/SSPropor.htm). The 107 students who agreed to participate in the study and submitted the "Introductory Characteristics Form for the Student Group", "Principles of Asepsis Knowledge Test" (pre-test) and "Self-directed Learning Skills Scale" were divided into experimental and control groups by the researcher through randomization program (https://www.randomizer.org/). Since the research was designed to be conducted with two independent groups, a power analysis was performed with the G*Power 3.1 program and when the effect size was analyzed as 0.79, power 95% and significance level 0.05, the minimum sample size in both groups was determined as 43 students (Aksoy and Paslı Gurdoğan, 2022). The study was conducted with 53 students in the experimental group and 54 students in the control group. The study was registered on ClinicalTrials.gov and received the number NCT06166966 on the date of sending the videos and study tools to the students.

2.4. Data collection tools

Data were collected through "Descriptive Characteristics Form of Nursing Students", "Principles of Asepsis Knowledge Test" and "Self-directed Learning Skills Scale".

2.4.1. Descriptive Characteristics Form of Nursing Students

The form was composed of items inquiring about age, gender, frequency of computer and smartphone use, and the age at which smartphone use started.

2.4.2. Principles of asepsis knowledge test

The related test was prepared by the researcher by reviewing the literature (Aşkın Tekkol and Demirel, 2018; Chen et al., 2020; Hwang et al., 2021; O'Connor, 2023). The test included 10 questions including definitions of asepsis principles, principles of surgical asepsis and contamination concepts. In order to ensure the validity and reliability of the test, expert opinion was obtained from three faculty members who are experts in their fields. It was determined that the experts largely provided appropriate opinions and the expert opinions on the form were statistically compatible (Kendall's W=0.333; p=0.468). The related test was finalized based on the opinions of the experts.

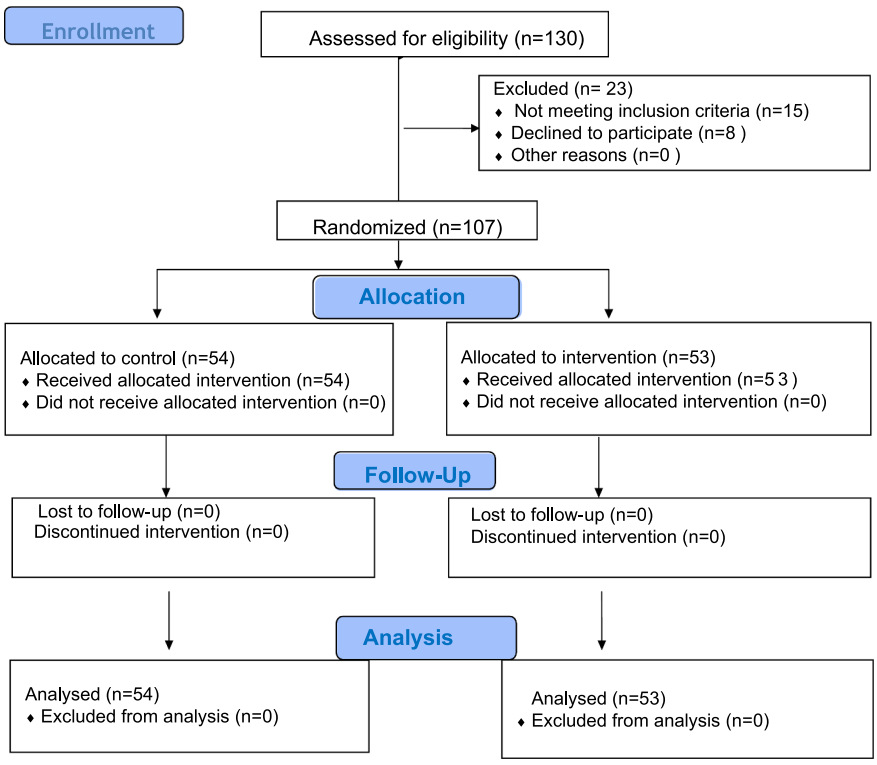

Fig. 1. CONSORT diagram of this study.

2.4.3. *Self-directed learning skills scale*

The scale was developed by Aşkın Tekkol and Demirel (2018) with 2600 students to determine self-directed learning skills. The scale is a five-point Likert-type scale. As a result of the analysis of the scale, it was observed that the fit indices of the scale were between good fit and acceptable values and the structure of the scale consisting of 4 factors and 21 items was confirmed as a model. The reliability of the scale calculated with Cronbach Alpha internal consistency coefficient was determined as 0.895. In this study, the Cronbach Alpha internal consistency coefficient of the scale was determined as 0.834.

2.5. *Preparation of digital materials*

For flipped learning, materials such as demonstration video, puzzle, word cloud study, which were determined by the researcher for out-of-class learning, as a requirement of the flipped learning model, were submitted to the students' phones as a link so that they could watch and practice at any time they wanted. These materials include;

- **Edpuzzle:** It is a free platform where sounds, open-ended or multiple-choice questions can be integrated into pre-prepared videos or existing videos on platforms such as Youtube and Khan Academy, and interactive course content can be created. The video link to be transmitted to the students by the researcher on this platform is; https://edpuzzle.com/media/652269e1a0c2e04000f8b3e4, and the theoretical lecture notes were also included in the system at the time of the implementation.
- **Word Art:** Word cloud creation program (This program was utilized during the implementation and was freely available). Researcher's program registration; https://wordart.com/cmes7zi7uqpb/word-art%201
- **Crossword Puzzle:** A puzzle with definitions of asepsis principles was developed and shared with students. https://crosswordlabs.com/view/asepsiye-iliskin-tanmlar

2.6. *Procedure and application of the study*

The students who would participate in the study were initially asked to fill out the "Descriptive Characteristics Form of Nursing Students", "Principles of Asepsis Knowledge Test" and "Self-directed Learning Skills Scale" forms (November 08, 2023). The forms were filled out at separate times to prevent the groups from interacting with each other. Learning objectives related to asepsis principles were determined according to Bloom's taxonomy. The learning activities carried out with the experimental and control groups in the implementation of the research are given below (Fig. 2).

The experimental group students were informed about how to practice the flipped learning model. The researcher formed a WhatsApp group consisting of the experimental group students and sent the links of the digital materials to the students via WhatsApp. The experimental group students worked on the digital materials two weeks before the principles of infection control and asepsis course and accessed the links from their mobile phones (November 11-November 29, 2023). A mini lesson was conducted in which the information they learned in the videos was summarized and the points they did not understand were emphasized (November 29, 2023). After the lecture, a theoretical lesson was held and students were allowed to practice the principles of asepsis under the supervision of the researcher in the nursing laboratory (November 30-December 02, 2023). At the end of the implementation repetitions of the students, the post-test was performed on December 06, 2023. In this context, experimental group students were trained for four weeks. Two weeks after the post-test, a knowledge test (follow-up test=retention test) was performed again (December 20, 2023) and the knowledge levels of the experimental group students were examined.

Control group students received training on the principles of asepsis during class hours and no resources were provided to the students to prepare before the class hours. They received three hours of theoretical, two hours of demonstration and four hours of laboratory practice training on the principles of asepsis in the Principles of Nursing-I course on infection control and completed the post-test. The training given to control group students is the standard training given within the scope of

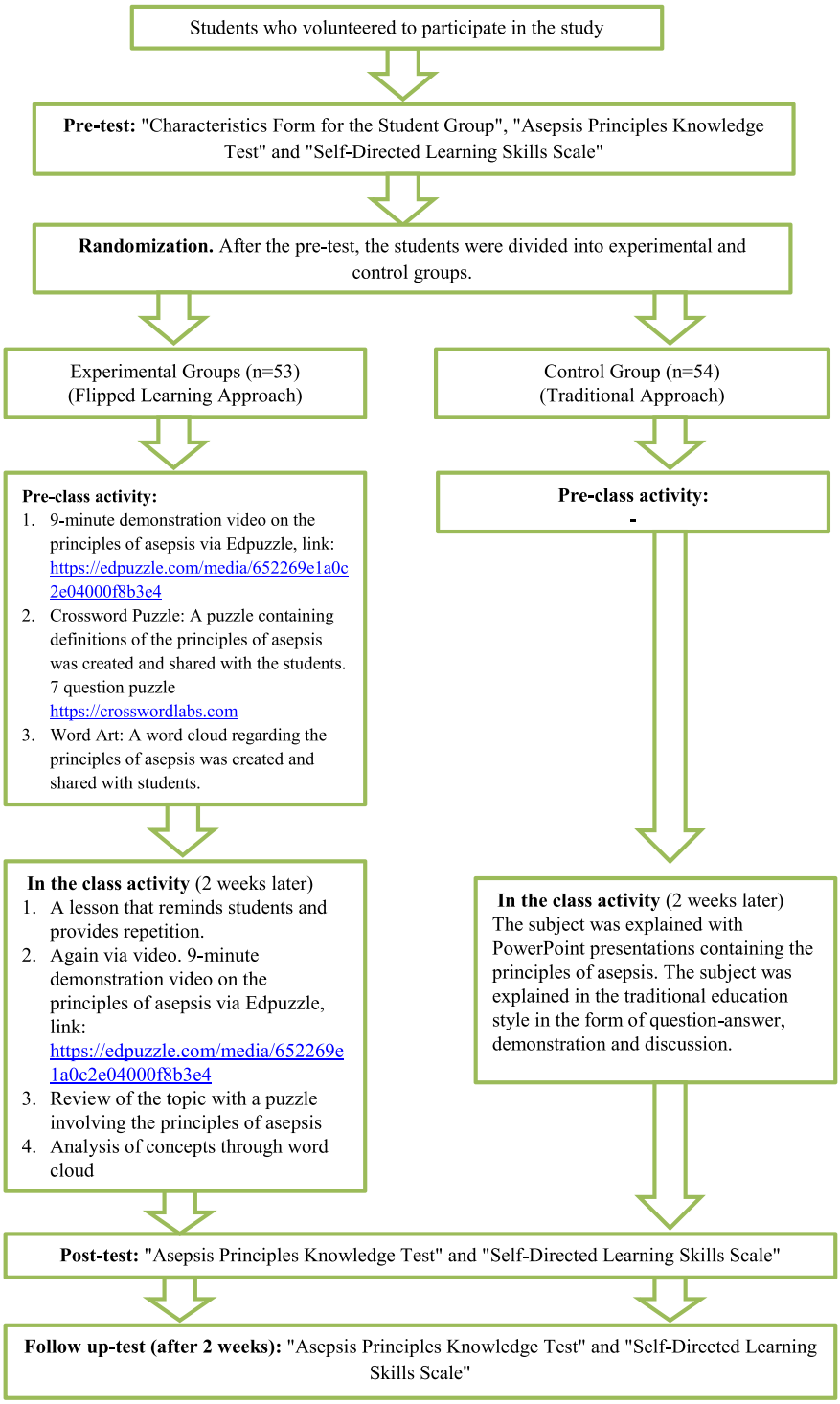

Fig. 2. caption.

the Principles of Nursing course. Standard education is the same for both groups. Two weeks after the post-test, a knowledge test (follow-up test=retention test) was conducted again (December 20, 2023) and their knowledge levels were examined.

At the end of the study, the researcher shared the materials shared with the experimental group for the flipped learning method with the control group students.

2.7. Data analysis

The data of the study were analyzed with the SPSS program (version 22.0; SPSS, Inc., USA). Descriptive statistical methods were utilized to determine the number, percentage, mean, standard deviation, median, interquartile range (IQR), minimum and maximum. Normality of the data was evaluated by the Kolmogorov-Smirnov test. The Mann Whitney-U test and Wilcoxon Signed Ranks test were performed to analyze non-normally distributed data. Chi-square ($\chi 2$) test was conducted to determine the relationship between two variables and analysis

of variance in dependent groups was carried out to analyze the data related to repeated measurements. In the evaluation of effect size; it was accepted as d:0.1–0.3: small effect, d:0.3–0.5: medium effect, d:0.5 and above: strong effect (Cohen, 2013). The significance level was regarded as $p < 0.05$ in the evaluation of the data.

2.8. Ethical considerations

Ethics committee approval and institutional permission were obtained from the university where the study would be conducted (E-10333602–050.04.01-218607). All students were informed about the purpose of the study, confidentiality and online digital teaching materials. They were informed that they could leave the study at any time. Consent was obtained from all students. At the end of the study, all materials were shared with the control group students.

3. Results

There was no statistically significant difference between the control and experimental groups in the distribution of the students participating in the study according to their descriptive characteristics ($p>0.05$) (Table 1).

It was determined that the experimental group's post-test knowledge score median was statistically significantly higher than the control group ($p=0.000$) and the difference had a medium effect ($d=0.35$). It was found that the median of the retention test knowledge score of the experimental group was statistically significantly higher than the control group ($p=0.000$) and the difference had a strong effect ($d=0.54$). It was determined that the difference between the knowledge score medians of the students in the control group between the three measurements was statistically significant ($p=0.000$) and all measurements were different from each other. In the experimental group, the difference in the median knowledge score between the three measurements was statistically significant ($p=0.000$) and there was a difference between the pretest, posttest and retention test (Table 2).

There was no significant difference between the control and experimental groups in the posttest mean scores of the total scale and subdimensions ($p>0.05$). When the within-group differences were examined, it was determined that there was a statistically significant decrease ($p<0.05$) in the median of the self-monitoring sub-dimension and scale total scores of the experimental group and that the difference had a strong effect ($d>0.5$). The experimental group had a statistically significant increase ($p<0.05$) in the median score of the self-control subscale and the difference had a strong effect ($d>0.5$) (Table 3).

Table 1
Descriptive characteristics of nursing students.

Characteristic	Groups				Statistics
	Control		Experimental		
	n (54)	%	n (53)	%	
Age ($\bar{x}\pm SS$)	19.64 ± 2.84 (Min: 17; Max: 36)		19.37 ± 1.83 (Min: 17; Max: 28)		χ^2=63.253 p=0.481
Age of starting to use a smartphone ($\bar{x}\pm SS$)	14.20 ± 2.55 (Min: 6; Max: 22)		14.11 ± 2.00 (Min: 10; Max: 19)		χ^2=45.585 p=0.540
Gender					
Famale	35	64.8	38	71.7	χ^2=0.157
Male	19	35.2	15	28.3	p=0.756
Frequency of computer use					
I don't use	30	55.6	31	58.5	χ^2=13.233
1–2 h a day	13	24.1	14	26.4	p=0.084
3–4 h a day	9	16.6	6	11.3	
More than 4 h a day	2	3.7	2	3.8	
Frequency of smartphone use					
I don't use	-	-	1	1.9	
1–2 h a day	7	13.0	8	15.1	p=0.085*
3–4 h a day	27	50.0	19	35.8	
More than 4 h a day	20	37.0	25	47.2	

$\bar{x}$ = Average; SD = Standard deviation; Min: Minimum; Max: Maximum; χ2: Chi square test
*: Since Fisher's exact chi-square test was used, there is no χ2 value

4. Discussion

One of the learning methods developed with today's technology is the flipped learning model. In the most basic sense, flipped learning refers to students engaging in some kind of preparatory work before attending the lesson (Pilcher, 2019). As in all fields, the flipped learning model makes a impact on students in nursing education. It is reported that the flipped learning model increases performance in nursing education and is considered sufficient and positive by both students and faculty members (Barranquero-Herbosa et al., 2022). In this study, the flipped learning model was implemented with first-year nursing students, and a positive effect was observed on students' asepsis knowledge and learning skills.

4.1. The effect of flipped learning on knowledge

It was observed that the post-test knowledge score of the experimental group was statistically significantly higher ($p=0.000$) than the control group. This result of the study is similar to the literature (Bıyık et al., 2023; Barranquero-Herbosa et al., 2022; Qutob, 2022; Zheng et al., 2022). With 103 Medical Faculty students, the training results of the students in the group in which the inverted classroom model was implemented in the Mass Accident Triage training were detected to be higher than the other group (Zheng et al., 2022). In a study with medical interns receiving clinical skills training, it was concluded that most of the students believed that watching videos was a great way to prepare for class (97.6%), that watching videos increased their learning ability (88.1%), and that they were able to accept this form of teaching (85.7%) (Zhang et al., 2022). In a study conducted with students enrolled in Hematology courses, after the training provided with the flipped learning model, a significant increase was observed in the exam scores of the experimental group students compared to the students in the other group ($p<0.001$) (Qutob, 2022). In another study conducted in 2019 with a total of 92 newly recruited nurses, it was determined that providing practices related to the profession with the flipped learning model before starting the profession significantly increased the independent learning ability, learning motivation, self-management ability, learning and cooperation ability and knowledge score in the intervention group ($p<0.05$) (Liu et al., 2022). These results demonstrate the success of the flipped learning model, which is different from traditional education.

In this study, the group to which the flipped classroom model method was applied was more dynamic both in terms of knowledge level and application skills. Students stated that the concepts related to the subject are simpler and more understandable in digital materials. They stated that the opportunity to watch the materials whenever they wanted as many times as they wanted made learning fun. Students stated that they watched the digital materials when they were productive in terms of learning. The active participation of the experimental group students during the laboratory applications reveals that the flipped learning has a positive effect on all students regardless of their academic achievement. These results show that the flipped learning model relaxes students and encourages them to learn. In addition, it is noteworthy that the median follow-up test knowledge score of the experimental group after the posttest was statistically significantly higher than the control group ($p = 0.000$). This result shows that the flipped learning supports permanent learning in students.

Table 2
Pre-test, post-test and follow-up test knowledge scores of students in the control and experimental groups.

Knowledge scores	Groups						Effect size	Statistics
	Control group (n=54)			Experimental groups (n=53)				
	Median (IQR)	Min	Max	Median (IQR)	Min	Max		
Pre-test[A]	34.44 (10.00)	.00	60.00	35.28 (10.00)	.00	60.00	0.28	Z= −0.366 p= 0.714
Post-test[B]	65.55 (30.00)	10.00	90.00	90.75 (10.00)	60.00	100.00	0.35	Z= −7.492 **p= 0,000***
Follow-up[C]	60.55 (25.00)	15.00	85.00	84.90 (25.00)	30.00	100.00	0.54	Z= −6.221 **p= 0,000***
Difference between groups	A < C < B			A < C, B				
Statistics	F= 154.266 **p= 0.000***			F= 83.670 **p= 0.000***				

IQR =Quartile range; Min: Minimum; Max: Maximum; Z = Mann Whitney U test; F: Variance Analysis in Dependent Groups; *p < 0.05

Table 3
Self-directed learning skills scale pretest and posttest scores of students in the control and experimental groups.

Scale and sub-dimensions		Groups						Effect size	Statistics
		Control group (n=54)			Experimental group (n=53)				
		Median (IQR)	Min	Max	Median (IQR)	Min	Max		
Self -monitoring	**Pre-test**	10.00 (4.00)	5.00	15.00	10.00 (3.50)	5.00	17.00	0.31	Z= −0.904 p= 0.366
	Post-test	8.00 (4.25)	5.00	15.00	9.00 (4.50)	5.00	17.00	0.44	Z= −0.298 p= 0.765
	Effect size	0.41			0.51				
	Statistical evaluation	z= −1.074 p= 0.283			z= −2.465 **p= 0.014***				
Motivation	**Pre-test**	11.00 (6.25)	7.00	21.00	11.00 (6.00)	7.00	21.00	0.46	Z= −0.952 p= 0.341
	Post-test	9.50 (4.00)	7.00	19.00	10.00 (6.00)	7.00	20.00	0.54	Z= −0.095 p= 0.924
	Effect size	0.57			0.60				
	Statistical evaluation	z= −1.195 p= 0.232			z= −1.587 p= 0.113				
Self-control	**Pre-test**	11.00 (5.00)	5.00	17.00	10.00 (4.00)	5.00	20.00	0.48	Z= −0.288 p= 0.773
	Post-test	10.00 (5.00)	5.00	21.00	10.00 (5.00)	5.00	23.00	0.59	Z= −1.142 p= 0.254
	Effect size	0.71			0.65				
	Statistical evaluation	z= −0.988 p= 0.323			z= −2.883 **p= 0.004***				
Confidence	**Pre-test**	6.00 (2.25)	4.00	15.00	6.00 (2.00)	4.00	10.00	0.29	Z= −0.247 p= 0.805
	Post-test	6.00 (3.00)	4.00	10.00	5.00 (3.00)	4.00	10.00	0.32	Z= −0.996 p= 0.319
	Effect size	0.42			0.48				
	Statistical evaluation	z= −0.700 p= 0.484			z= −1.752 p= 0.080				
Scale Score Average	**Pre-test**	36.00 (16.00)	21.00	57.00	38.00 (11.00)	21.00	66.00	0.63	Z= −0.739 p= 0.460
	Post-test	34.50 (15.00)	21.00	52.00	33.00 (18.00)	21.00	63.00	0.61	Z= −0.718 p= 0.473
	Effect size	0.78			0.71				
	Statistical evaluation	z= −1.195 p= 0.232			z= −2.733 **p= 0.006***				

IQR =Quartile range; Min: Minimum; Max: Maximum; Z = Mann Whitney U test; z= Wilcoxon Signed Ranks test; *p < 0.05.

4.2. The effect of flipped learning on retention and self-directed learning

In the study, it has been seen that the total score of self-directed learning skills scale was significant in the experimental group. This result is similar to the literature. Khodaei et al. (2022) investigated the effect of online flipped learning on self-directed learning readiness and metacognitive awareness in second-year nursing students (n=34) during the COVID-19 pandemic and concluded that this model increased the participants' readiness for self-directed learning. In another study conducted by Bıyık Bayram et al. (2023) with 94 first-year nursing students on blood pressure measurement, it was concluded that flipped learning model was significantly effective in students' success and self-directed learning. In addition, there was a statistically significant increase ($p<0.05$) in the "self-control" sub-dimension score median of the experimental group and the difference had a strong effect ($d >0.5$). In a study by Govindan et al. (2023) with nursing students enrolled in Anatomy and Physiology courses, it was observed that there was a significant increase in the "self-control" levels of students after the training provided with online blended self-directed learning. In another study conducted with nursing students in three different countries during the Covid-19 pandemic, it was determined that a significant increase was observed in both "self-control" and "motivation" of students with online supported self-directed learning (Grande et al., 2022).

In this study, the strengthening of the "self-control" dimension in the

group where the flipped learning was applied indicates that students' abilities to control themselves and manage their emotions and behaviors to achieve long-term goals are strengthened. This result emphasizes that students' planning, problem-solving and decision-making skills are strengthened. In the flipped learning model, students stated that they could access course materials at the time they wanted to learn. Studying whenever they wanted increased permanent learning as well as helped them be ready to discuss points that needed to be discussed with the instructor. It was observed that the students in the experimental group, where the flipped learning was applied, were more active in both theoretical lessons and laboratory practices and asked questions for understanding.

These results indicate that the online learning model is on nursing effective students and the retention of the learned information. It is seen that flipped learning is useful in many parameters such as taking responsibility, critical thinking, decision making, analyzing, synthesizing and self-evaluation. This is an indication that students can be more successful with the support of the instructor. Unlike these results, some studies have also indicated that despite students' positive sense for the flipped learning, there is no significant difference in exam scores between the students in the flipped classroom and in classical learning environment (Sajid et al., 2016). In addition, a disadvantage of the flipped learning was also observed. This disadvantage made it challenging for an instructor to manage and guide student groups and evaluate each student's performance. When the number of faculty members is higher, the relevant method is thought to be applied much more easily.

The fact that this research is based on infection control, which is one of the most important parameters in the field of health, and is focused on the rules of asepsis that students must learn and develop skills, reveals the originality of the research. Students were able to study their asepsis principles knowledge and skills without time constraints with alternatives such as videos, puzzles and word clouds. The research focused on students' self-learning ability and improved their ability to take responsibility.

4.3. Limitations

The limitations of this study include the fact that it was conducted only with first-year nursing students taking the Fundamentals of Nursing course at a university, uncertainty of the students in the control group were informed about the study and they developed self-learning skills, and the experimental group students may not have watched or worked on the online materials sufficiently.

5. Conclusion

This study reveals the success of the flipped learning model in nursing students. The students' utilization of online materials without time limit in developing knowledge and skills related to the principles of asepsis was reflected in the knowledge test results and demonstrated that the retention level persisted. The fact that the "self-control" subdimension of the self-directed learning skills scale was significantly higher in students who were implemented the flipped learning model indicates that instructors should integrate the model into the education system in learning the accurate knowledge and skills. Developing technology also supports online learning. This research was conducted on the principles of asepsis, which is the basis of infection control. It is recommended that the flipped classroom model be used with different subjects in teaching basic nursing skills with sufficient number of faculty members.

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I have completely uploaded my revision text, which I prepared in line with your and our referees' valuable opinions, to the system.

Declaration of Competing Interest

There is no conflict.

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