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Research Article

Influencing Factors on Nursing Students' Learning Flow during the COVID-19 Pandemic: A Mixed Method Research

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SUMMARY

Purpose: This study aimed to investigate the factors affecting nursing students' learning flow in COVID-19 pandemic situations through mixed-method research.

Method: Of the 245 nursing students participating in the survey, 20 participated in a focus group interview. Quantitative data were analyzed using stepwise multiple regression analysis. Qualitative data were analyzed using content analysis.

Results: The factors affecting the learning flow of nursing students during the COVID-19 pandemic were their self-regulated learning ability ($\beta = .24, p = .001$); learning motivation ($\beta = .23, p = .001$); self-efficacy in clinical practice ($\beta = .14, p = .014$); and lecture type, or a mixture of recorded and real-time video lectures ($\beta = .13, p = .022$). As a result of the qualitative study, eight categories and 22 subcategories were derived. The eight categories are: a lack of preparation in the starting of virtual classes, adapting and growing in a new learning environment, enhancing nursing knowledge and skills through virtual clinical training, self-regulation difficulties when studying alone due to social distancing, difficulty concentrating when learning online, disadvantages of virtual learning, concerns about academic performance, and missing opportunities to enjoy college life.

Conclusion: Students attempted to discover their own learning expertise through virtual learning while concerned that they would be unable to fully establish their competence to work as actual hospital nurses due to a lack of clinical practice. In such a learning environment, systematic support and strategies are needed to increase the learning flow of nursing students.

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Introduction

The world was significantly impacted by the coronavirus (COVID-19) pandemic in 2020. As each country was quarantined to prevent virus transmission, people experienced significant changes in their daily lives. Although students and instructors were not fully prepared, virtual lectures began online during the national disaster situation [1].

When the COVID-19 pandemic struck in 2020, Korea converted most university classes to virtual instruction as a part of social distancing and in accordance with the Ministry of Education guidelines. Clinical practice has also been restricted in healthcare

centers for the safety of patients and students [2]. Nursing students were also required to take online classes to prepare for clinical practicums, which required nursing competency in the healthcare field [3], as well as national certification exams. Nursing students in the COVID-19 situation have experienced significant changes in their learning, such as a decrease in clinical practice due to virtual classes, difficulty concentrating on continuous learning [4], and difficulty interacting due to a decrease in direct contact with instructors [5]. Nursing students needed to maximize their potential and maintain high concentration in the process of acquiring theoretical and practical skills to grow as healthcare workers in this changing learning environment.

The learning flow piques the learner's interest in learning and encourages students to participate in active learning activities [6]. Virtual classes reduce the interaction between instructors and students, and a lack of study-related equipment reduces learning flow [1,5]. Clinical practice is also limited in terms of acquiring various nursing roles because it is based solely on indirect

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experiences within a limited virtual scenario [7]. Consequently, a strategy is required to enable nursing students to immerse themselves in learning and facilitate high academic achievement, even in virtual learning environments.

Self-regulated learning is one strategic effort to achieve a high learning flow [8]. Learners with self-regulated learning abilities engage in goal-oriented behaviors during the learning process and can demonstrate high concentration by practicing academic self-regulation, or specifically, by developing and implementing learning strategies [8]. During the COVID-19 pandemic, in which sudden changes have resulted in virtual classes, the learner's ability to self-regulate their learning is especially important because each learner must learn at their own pace without the assistance of peers or instructors [9].

Students with high self-efficacy also have confidence in their ability to complete tasks and have a strong sense of emotional control, which leads to a high learning flow experience and successful academic achievement [10]. Nursing students with a high sense of self-efficacy can positively control and cope with their emotions, allowing them to actively participate in clinical practice [11]. To respond effectively and creatively to the rapidly changing clinical practice educational environment caused by the COVID-19 pandemic, nursing students must believe that they can complete tasks without abandoning them, even in challenging situations.

Instructors can induce learners' active participation and cognition through various interactions, such as feedback and advice on learning activities and expressing interest and encouragement [12]. Fostering this instructor-student interaction is critical for inducing a successful learning flow [13].

The interaction between learners is defined as a self-directed, two-way communication activity in which learners create meaning through exchanging messages and sharing information with other students [14]. While interpersonal relationships have become difficult due to the COVID-19 pandemic, the need still exists for a plan to increase learners' interactions to ensure more effective academic achievements.

Learning motivation is a force that arouses a learner's interest or their strong tendency or will to learn, and it is one of the most important factors for students to engage in active learning [15]. Learning motivation encourages learners' activities and directs and maintains their progress, allowing students to immerse themselves in learning [16]. However, virtual learning decreases students' attention and interest in classes, which then decreases their motivation to learn [17]. For improving academic achievement during COVID-19, it is necessary to consider the types of motivation that can increase students' interest.

Self-leadership, academic self-efficacy [18], and positive psychological capital [19] were factors that influenced nursing students' learning flow prior to the COVID-19 pandemic. Factors related to the learning flow of nursing students in virtual education after the COVID-19 pandemic include learning motivation [20], quality of teaching and professional support [21], and online practice experience of nursing students [2]. However, research on the learning flow of nursing college students in a changing learning environment following the COVID-19 pandemic is still in its early stages.

To accurately reflect the learning situations altered by the COVID-19 pandemic, it is necessary to conduct a practical, diverse investigation of students' experiences in the current situation using a mixed-method research approach that combines quantitative and qualitative methods. Hence, this study aims to use the mixed-method approach to better understand the factors influencing the learning flow of nursing students, who must combine theoretical and practical education during the COVID-19 situation. We will prepare basic data for plans and intervention measures that will

assist nursing students in increasing their learning flow in a learning situation caused by COVID-19.

Methods

Study design

This study uses an explanatory, sequential mixed method that interprets the overall result by converging and merging qualitative data into quantitative data to understand the impact on the learning flow of nursing students during the COVID-19 pandemic. We identified the factors affecting students' learning flow by first conducting descriptive research as a quantitative research method. As a subsequent qualitative research method, we investigated the content of their experiences related to their learning flow through a focus group interview. The explanatory, sequential mixed method as a combined research design aids general logic and understanding through quantitative research and allows for the analysis and correction of statistical results from quantitative research by combining qualitative research methods. This is advantageous, as it highlights phenomena that would not have been discovered through solely quantitative research [22].

Setting and samples

The targets of quantitative data collection were third- and fourth-year undergraduate nursing students (as of 2020) in three colleges located in the Republic of Korea. The subjects were students who had participated in virtual lectures, as well as actual clinical practice. The students understood the study's purpose and willingly agreed to participate in the research.

The study's sample size was calculated using a two-sided test for a regression analysis using G*power software, version 3.1.9.7. As a result of calculations based on the significance level or specifically, $\alpha = .05$, the effect size = .15, and the ability to test $(1 - \beta) = .95$ and 23 predictors, the minimum sample size was 234 people. By considering a dropout rate of 10.0%, the questionnaire was distributed online to 260 students. The final analysis used data from 245 people, excluding 15 questionnaires with insincere or incomplete responses.

Regarding the qualitative data-collection target, convenience sampling was performed on participants who were willing to take part in the research and who would provide a detailed description of their experiences. The sample size of a small group required for Krueger's suggested focus group interview is four to six people [23]. Thus, five focus group interviews were conducted, with a total of 20 people and 3 to 5 people in each group.

Ethical consideration

This study was approved by the institutional review board of the Gyeongsang National University (Approval no. GIRB-A21-Y-0008).

Measurements

General and learning-related characteristics

The general characteristics (gender, age, and grade as of 2020) and virtual learning-related characteristics (lecture locations, lecture learning tools, technical difficulties in such lectures, attendance patterns, the number of assignments, the number of the lectures, sleep patterns, disadvantages, and advantages) were structured.

It was necessary to clarify students' learning experiences following the COVID-19 pandemic when they responded to the

survey. Thus, the phrase “after the COVID-19 pandemic” was added to the beginning of each survey question.

Learning flow

This survey used the learning flow scale for adult learners as developed by Kim et al. [24]. This scale has nine subareas and 29 items and is composed of a five-point Likert scale, with a higher score indicating a higher degree of immersion. In the study by Kim et al. [24], Cronbach's α was .94; in this study, Cronbach's α was .92.

Self-regulated learning ability

For measuring the respondents' self-regulated learning ability, the self-regulated learning ability test tool developed by Gu [25] was used to measure the learning effect of adult learners in distance education, as modified and supplemented for adult learners by Choi [26]. This consists of seven items on a five-point Likert scale, with higher scores indicating a better ability to self-regulate learning. The reliability coefficient Cronbach's α as calculated by Gu [25] was .83, Choi's [26] Cronbach's α was .88, and that in the current study was .81.

Self-efficacy in clinical practice

As a self-efficacy tool for clinical practice, this study incorporated the self-efficacy measurement tool developed by Ahn [27], which is a combination of the Nursing Clinical Self-Efficacy Scale developed by Harvey and McMurray [28] and Parker's [29] self-efficacy tool for nurses. The phrasing was modified to fit the COVID-19 pandemic situation for nursing students. It consists of 25 questions and a 10-point Likert scale, with higher scores indicating higher self-efficacy in clinical practice. In Ahn's [27] study, the Cronbach's α was .94, and in this study, the Cronbach's α was .96.

Instructor-student interactions

The e-learning interaction evaluation tool developed by Ahn [30] for elementary and middle school students was modified and supplemented by Park [31] for cyber university learners in the first part of each question. The questionnaire consisted of seven questions asking how the instructor encourages interactions, with a five-point Likert scale for responses. A higher score indicates higher interaction. In An's [30] study, the Cronbach's α was .87; in Park's [31] study, the Cronbach's α was .93; and this study's Cronbach's α was .91.

Student-student interactions

In order to examine the student-student interaction, the questions of the “Survey on the interaction of learners using social media” were developed by Choi [32]. This portion of the questionnaire consisted of two subdomains with 12 items on a five-point Likert scale, with a higher score indicating higher interaction. In Choi's [32] study, the Cronbach's α was .91, and in this study, the Cronbach's α was .91.

Learning motivation

The learning motivation test tool developed by Keller and Song [33] for learners was modified and supplemented by Choi [26] for adult learners, and the related phrasing was used to measure learning motivation in the current survey. It comprised four subdomains and 23 items on a five-point Likert scale; the higher the score, the stronger the motivation to learn. The reliability coefficient Cronbach's α , as calculated by Keller and Song [33], was .88, the Cronbach's α was .89 in Choi's [26] study, and the Cronbach's α was .86 in this study.

Semi-structured questionnaire used in qualitative research

An open-ended interview was conducted regarding learning experiences in the context of the COVID-19 pandemic using a semi-structured interview questionnaire, as suggested by Krueger [23]. The specific interview questions were as follows:

- ◆ Introduction: Please tell us about the COVID-19 pandemic's impact on you.
- ◆ Transition: Please tell us how the COVID-19 pandemic has affected your learning.
- ◆ Key question: Please tell us about an experience in which you were well-immersed in learning or faced a difficult experience.
- ◆ Closing: What are the difficulties you have experienced other than in class and practice?

Data collection

Data for this study were collected from March 8 to April 17, 2021, at three nursing colleges located in the Republic of Korea. With permission from each university, enrollment notices were posted on department bulletin boards and group social networks, and subjects who voluntarily consented were recruited. For recruiting participants for the qualitative research, the purpose and method of the interview were explained to students who had previously completed the questionnaire, and students who wished to participate voluntarily were selected.

The students in this study had all previously completed virtual lectures, virtual practicums, and real-world healthcare system practicums. Some differences were observed in the operation of face-to-face and virtual classes among the three universities.

Data analysis

Quantitative data analysis

The collected data were analyzed using SPSS software, version 25.0 (IBM Corp., Armonk, NY, USA), with the analysis method as follows.

Descriptive statistics were used to calculate the characteristics of the study subjects and the degree of self-regulated learning availability, self-efficiency in clinical practice, instructor-student interactions, student-student interactions, and learning motivation. The Cronbach's alpha coefficient was used to confirm the research tool's reliability. The independent *t*-test or one-way ANOVA was used to compare major variables based on the study subjects' characteristics; Scheffe's test was used as a post-test. The Pearson's correlation coefficient confirmed the correlation between the main variables, and a stepwise multiple regression analysis was used to identify the factors affecting learning flow.

Qualitative data analysis

After the focus group interview was transcribed, Elo and Kyngäs' [34] content analysis method was used. The data obtained through the interviews were repeatedly reviewed, and related words or phrases were underlined and annotated in the margins. Main statements, including key content, were extracted; and open coding was performed to create categories and an abstraction. The analyzed data were then peer-reviewed by a nursing professor specializing in qualitative research, two professors with extensive educational experience, and one researcher with experience in qualitative research and attendance at various qualitative research seminars.

Rigor

For ensuring rigor in the qualitative research, the data were evaluated based on the criteria suggested by Guba and Lincoln [35].

The researchers confirmed its credibility by selecting participants with sufficient learning experience after the COVID-19 pandemic; they repeated the same questions during the interview and tried to describe the statements of the participants as they were. To prevent any omission or distortion of the interview content, the author reconfirmed the interview content with the participants after the interview was completed and randomly matched the transcript with the audio file to determine whether the transcript was accurately transcribed. To increase applicability, the researchers continued to collect and analyze data cyclically until the participants' statements reached a theoretical saturation point, at which new content was no longer produced. Additionally, after analyzing the interview data, two participants were asked if the content was clearly analyzed. To increase consistency, two researchers with comprehensive qualitative research experience repeatedly discussed the data analysis and interpretation of the results. Finally, neutrality was increased by separating the author's words through bracketing in the data collection and analysis processes; neutrality was subsequently maintained by eliminating the author's subjectivity and prejudice.

Results

Quantitative research results

Subjects' general and learning-related characteristics (Table 1)

The average age of the subjects was 22.91 ± 2.50 years; regarding gender, 196 were women (80.0%), and 49 were men (20.0%). Most of the virtual learners observed lectures from home (93.5%). The most common technical difficulties in virtual lectures were the "connection failure as a result of too many users" (47.3%) and "building a high-quality internet communication network (such as Wi-Fi)" (39.2%). Regarding the number of assignments in virtual settings, 62.4% answered "too much," and 36.3% said they were "appropriate." The virtual lecture types included "combining recorded lectures and real-time video lectures" (53.9%), "real-time video lectures" (29.8%), and "recorded lectures" (15.5%). Of the disadvantages of virtual lectures, the most common were the "difficulty in maintaining concentration while in class" (66.1%) and "difficulty in self-learning" (38.4%). Regarding the degree of change in sleep patterns during virtual lectures, 40.4% answered "no change," while 59.6% replied, "a small change" or greater. As for the effects and advantages of virtual lectures, the most common responses were "no restriction on class time and place" (81.2%) and "repeated learning with video playback" (64.5%).

Subjects' self-regulated learning ability, self-efficacy in clinical practice, instructor-student interactions, student-student interactions, learning motivation, and degree of learning flow (Table 2)

The learning flow was rated as 3.09 ± 0.51 of 5 points; self-regulated learning ability was 3.06 ± 0.65 of 5; self-efficacy in clinical practice was 7.78 ± 1.28 of 10, and instructor-student interaction was 3.35 ± 0.73 of 5. Student-student interactions scored 3.11 ± 0.69 of 5, and learning motivation was 3.20 ± 0.44 of 5.

Differences in main variables depending on subjects' general and learning-related characteristics (Table 2)

No general characteristics exhibited differences in the subjects' learning flow, although, among the learning-related characteristics, the lecture type ($F = 5.84, p = .003$) exhibited a difference. The learning flow was higher in lectures presented as a combination of recorded and real-time video lectures than solely real-time video lectures.

Relationship between the variables related to subjects' learning flow (Table 3)

Learning flow was found to positively correlate with self-regulated learning ability ($r = .43, p < .001$), self-efficacy in clinical practice ($r = .28, p < .001$), instructor-student interactions ($r = .25, p < .001$), student-student interactions ($r = .18, p = .006$), and learning motivation ($r = .43, p < .001$).

Factors affecting the subjects' learning flow (Table 4)

The possible presence of auto-correlation and multicollinearity in the regression model were assessed through Durbin-Watson's statistic (1.97), the tolerance (0.60 to 0.97), and the variance inflation factor (1.03 to 1.66), confirming that the basic requirements for the regression analysis were satisfied. The analysis revealed that the variable with the greatest influence on learning flow was the self-regulated learning ability ($\beta = .24, p = .001$), followed by learning motivation ($\beta = .23, p = .001$), and clinical practice. Self-efficacy ($\beta = .14, p = .014$) and the type of lecture combining recorded and real-time video lectures ($\beta = .13, p = .022$) were found to have a major effect. In other words, the higher the self-regulated learning ability, learning motivation, and self-efficacy in clinical practice, the higher the learning flow in mixed lectures (combining recorded lectures and video lectures) rather than real-time video lectures, with an explanatory power of 27.1% ($F = 22.30, p < .001, R^2 = .271$).

Qualitative research results

Focus group interviews were conducted to determine the impact of virtual lectures and nursing students' clinical practice experiences on learning flow during the COVID-19 pandemic. The general characteristics of this study's focus group participants were as follows: Of the 20 people in five groups, 15 participants (71.0%) were female, and 5 participants (29.0%) were male, with an average age of 24 years. Regarding the grade, 13 students (65.0%) were juniors, and 7 (35.0%) were seniors.

The virtual clinical practice learning programs used in the three schools included Nursing Skills (produced by Elsevier), High-Fidelity Simulator, vSim® for Nursing (produced by Laerdal Medical), nursing case scenarios as developed by instructors, and videos related to nursing practice (YouTube).

Learning flow experience related to the COVID-19 pandemic

As a result of analyzing the interview data from the 20 participants in the focus group interview, eight categories and 22 sub-categories were derived; Table 5 displays their content.

A lack of preparation in the starting of virtual classes. Nursing students struggled in their studies because there were "inadequate communication networks, equipment, and facilities for virtual learning," such as computers with audio and video and free Wi-Fi. Participants claimed that "the number of assignments has increased" due to lecturers' concerns that students would not study in virtual classes. Further, respondents noted that it was difficult to concentrate in class when the "instructors just read off the slide word for word without further explanation or elaboration" in their video lecture recordings.

Adapting and growing in a new learning environment. Nursing students stated that the advantage of virtual classes is that they "can be listened to repeatedly at any time and from any location." Students felt that they had more time to focus on their studies because they saved time commuting. To adjust to virtual learning, participants "tried not to postpone learning and tried to find a learning method" to manage themselves by developing their "own

Table 1 Subjects' General and Learning-related Characteristics (N = 245).

Characteristics	Categories	n (%)	M±SD
Age (year)	21–41	245 (100)	22.91 ± 2.50
Gender	Women	196 (80.0)	
	Men	49 (20.0)	
Grade	Junior	113 (46.1)	
	Senior	132 (53.9)	
Virtual lecture learning place ^a	Home	229 (93.5)	
	Dormitory	48 (19.6)	
	Café	41 (16.7)	
	Library	19 (7.8)	
	Reading Room	16 (6.5)	
	Others	2 (0.8)	
Virtual lecture learning tool ^a	Laptop	211 (86.1)	
	Tablet PC	81 (33.1)	
	Smartphone	71 (29.0)	
	Desktop PC	33 (13.5)	
	TV	1 (0.4)	
Technical difficulties in virtual lectures ^a	Connection failure as a result of too many users	116 (47.3)	
	Building a high-quality internet communication network (e.g. WIFI)	96 (39.2)	
	Preparation of auxiliary equipment such as webcams and speakers	67 (27.3)	
	Equipment preparation for lecture access (e.g. computer, tablet PC)	32 (13.1)	
	Others	20 (8.2)	
Attendance patterns during virtual lectures	Take classes according to timetable	149 (60.8)	
	Take all classes at once	60 (24.5)	
	Split a lecture several times	26 (10.6)	
	Take lectures over and over again	7 (2.9)	
	Others	3 (1.2)	
Amount of assignments in virtual lectures	Too much	153 (62.5)	
	Appropriate	89 (36.3)	
	A little	3 (1.2)	
Virtual lecture type	Combining recorded lectures and real-time video lectures	134 (53.9)	
	Real-time video lectures	73 (29.8)	
	Recorded lectures	38 (15.5)	
	Others	2 (0.8)	
Disadvantages of virtual lectures ^a	Difficulty in maintaining concentration while in class	162 (66.1)	
	Difficulty in self-learning	94 (38.4)	
	Connection failure or slow transmission speed	81 (33.1)	
	Hesitating to ask questions to the professor	60 (24.5)	
	No answer after asking the professor	20 (8.2)	
	Difficulty preparing learning tools for taking classes	16 (6.5)	
	Others	11 (4.5)	
Degree of change in sleep patterns during virtual lectures	None	99 (40.4)	
	A little	92 (37.5)	
	Much	33 (13.5)	
	Too much	21 (8.6)	
Advantages of virtual lectures ^a	No restriction on class time and place	199 (81.2)	
	Repeated learning with video playback	158 (64.5)	
	Classes without risk of infection with COVID-19	148 (60.4)	
	Reduction of commuting time	72 (29.4)	
	Improving concentration	25 (10.2)	
	Others	3 (1.2)	

Note. M±SD = mean ± standard deviation.

^a Multiple responses.

schedule management method.” They proceeded “according to the timetable and tried to study by setting up a study plan.” Students were able to participate more actively in class when the “instructor encouraged interaction with the students” through chats or quizzes during their virtual classes, and they could be more immersed in the class when the “instructor prepared and applied various teaching methods in the virtual class.” Additionally, the participants stated that “interactions between students were facilitated due to the convenience of various video conferencing platforms (e.g., Zoom).”

Enhancing nursing knowledge and skills through virtual clinical training. Participants have been “able to gain a deeper understanding of specific medical conditions” after experiencing virtual clinical training (vSim® for Nursing). Additionally, the virtual simulation, included in the virtual clinical training, provided them “the overall procedures of nursing performance evaluations and

their significance in building confidence in the entire nursing process.” Nursing students felt that the virtual clinical training allowed them “to proactively try outperforming various medical treatments, improving their problem-solving skills using imaginary scenarios through case studies.” The respondents also believed that “if contactless clinical training preceded hospital in-person clinical training, the learning effect would be enhanced to improve their clinical performance ability.”

Self-regulation difficulties when studying alone due to social distancing. Participants noted that although they enjoyed the freedom to listen to lectures at their convenience through remote classes, they “put off watching the class video at the scheduled time.” These students were also anxious about the “pressure of having to carefully study results in repeatedly listening to the recorded lectures, thus increasing the time spent in lectures” and not missing any information. As the participants were concerned

Table 2 Degree and Differences in Main Variables depending on Subjects' General Characteristics and Learning-related Characteristics (N = 245).

Characteristics	Learning Flow (1–5)		Self-regulated learning ability (1–5)		Self-efficacy in clinical practice (1–10)		Instructor-student interaction (1–5)		Student-student interaction (1–5)		Learning motivation (1–5)	
	M±SD	t/F(p)	M±SD	t/F(p)	M±SD	t/F(p)	M±SD	t/F(p)	M±SD	t/F(p)	M±SD	t/F(p)
Gender	3.09 ± 0.50	–.70 (.483)	3.64 ± 0.66	–2.22 (.027)	7.70 ± 1.28	1.81 (.072)	3.32 ± 0.74	.90 (.368)	3.10 ± 0.67	–.02 (.985)	3.20 ± 0.45	–.57 (.570)
Man	3.04 ± 0.51		3.41 ± 0.52		8.07 ± 1.22		3.43 ± 0.67		3.10 ± 0.77		3.16 ± 0.37	
Grade	3.03 ± 0.52	–1.52 (.129)	3.57 ± 0.64	–.72 (.474)	7.63 ± 1.38	–1.69 (.093)	3.34 ± 0.74	–.08 (.936)	3.08 ± 0.67	–.50 (.619)	3.19 ± 0.41	–.09 (.926)
Junior	3.13 ± 0.49		3.62 ± 0.64		7.90 ± 1.17		3.35 ± 0.71		3.12 ± 0.70		3.19 ± 0.46	
Senior	3.10 ± 0.44	.71 (.542)	3.37 ± 0.67	3.50 (.016)	7.98 ± 1.13	1.21 (.306)	3.29 ± 0.66	1.25 (.293)	3.04 ± 0.74	1.04 (.377)	3.18 ± 0.43	.15 (.928)
Attendance patterns during virtual lectures	3.06 ± 0.52		3.66 ± 0.64	(.016)	7.65 ± 1.36	(.306)	3.41 ± 0.72	(.293)	3.15 ± 0.63	(.377)	3.20 ± 0.41	(.928)
Take all classes at once ^a												
Take classes according to timetable ^b												
Split a lecture several times ^c	3.09 ± 0.54		3.70 ± 0.54	a < b [†]	7.97 ± 1.06		3.15 ± 0.89		2.93 ± 0.86		3.25 ± 0.47	
Take lectures over and over again ^d	3.30 ± 0.51		3.71 ± 0.59		7.87 ± 1.20		3.24 ± 0.56		3.17 ± 0.55		3.19 ± 0.44	
Amount of assignments	3.06 ± 0.51	.51 (.599)	3.58 ± 0.67	.23 (.797)	7.74 ± 1.35	1.16 (.316)	3.31 ± 0.75	.65 (.524)	3.06 ± 0.65	.94 (.394)	3.15 ± 0.43	1.45 (.237)
Appropriate	3.11 ± 0.49		3.63 ± 0.60		7.87 ± 1.14		3.42 ± 0.69		3.17 ± 0.75		3.24 ± 0.46	
A little	3.29 ± 0.51		3.71 ± 0.37		6.81 ± .50		3.33 ± 0.21		3.30 ± 0.45		3.39 ± 0.19	
During virtual lectures	3.04 ± .048	5.84 (.003)	3.55 ± 0.65	1.32 (.269)	7.83 ± 1.14	4.42 (.013)	3.18 ± 0.70	2.28 (.104)	3.24 ± 0.74	.85 (.430)	3.11 ± 0.50	2.02 (.135)
Recorded lectures ^e												
Real-time video lectures ^f	2.94 ± 0.51		3.52 ± 0.59		7.42 ± 1.48		3.28 ± 0.79		3.07 ± 0.73		3.15 ± 0.39	
Lecture type	3.18 ± 0.50	F < g [†]	3.66 ± 0.68		7.96 ± 1.16	F < g [†]	3.44 ± 0.69		3.11 ± 0.69		3.24 ± 0.45	
Combining recorded lectures and real-time video lectures ^g												
Total	3.09 ± 0.51		3.60 ± 0.65		7.78 ± 1.28		3.35 ± 0.73		3.11 ± 0.69		3.20 ± 0.44	

Note. M±SD = mean ± standard deviation.
[†] Scheffe test.

about “missing something important while studying alone,” they watched videos “over and over again with anxiety,” which took much longer than a face-to-face class.

Difficulty concentrating when learning online. Participants said that “due to the free nature of such lectures, the reversal of daytime and nighttime occurs, leading to irregular lifestyles,” and such learning patterns result in decreased concentration. As virtual classes allow for repeated viewing, even if one missed a point, there was always an opportunity to watch again; thus, the importance of the class is diminished, with people “lacking concentration and possibly even doing something else in class.” Further, participants said that they would “lose concentration in virtual classes if it was boring or of relatively low importance.”

The participants studied late at night when they could focus well. Their lives “became erratic” as a result of excess morning sleep. When a real-time Zoom class occurred in the morning, they reported difficulty focusing.

Disadvantage of virtual learning. Participants also complained of “physical fatigue, such as eye and waist pain, or a worsening of eyesight due to long periods of staring at the screen.” Students were also often “unable to ask questions,” as they were afraid of either disrupting the flow of the class, if they were to ask a question in the middle of the video lecture, or they found the attention burdensome. Some participants felt that it was “more difficult to match schedules in order to set a meeting time and to reach an agreement in opinions” during online cooperative learning. They perceived “communication barriers between students via the video conferencing platform.” Students thought that they were “unable to effectively communicate since it was difficult to detect fellow students’ comments on the online platform and to motivate active engagement in the meeting.”

Concerns about academic performance. Nursing students expressed anxiety that their “academic performance would be degraded due to the transition to virtual classes.” Participants questioned “the effectiveness of the communication skills learned in virtual clinical training when applied in practice” and were worried that they would not be able to work well as new nurses or that it might affect their future employment.

Missing opportunities to enjoy college life. Students expressed that the “closure of school facilities, such as the school library or study rooms, due to COVID-19” had impacted their studies. Participants also felt “it was disappointing that their chances of interacting with other fellow students” had been reduced as a result of the COVID-19 ban on school events and club activities.

Discussion

This study explored the COVID-19 pandemic’s effect on the learning flow of nursing students using a mixed-method approach. A majority of the participants attended virtual, remote classes at home using their laptops. The students in this study studied the virtual course according to the timetable offered by the college in order to maintain the same sensation as the school class. Virtual lectures were conducted in the form of recorded lectures, real-time video lectures, or a combination of real-time and recorded lectures, consistent with the results of a study by Kim et al. [1] on nursing college students.

The average score for the subjects’ learning flow was 3.09 ± 0.51 of 5, or a moderate level. A slight difference was observed between before and after the COVID-19 pandemic, given the study by Lee et al. [36] of nursing students, with 3.19 out of 5; and 2.86 in Kim’s

Table 3 Relationship between Variables related to Subjects' Learning Flow (N = 245).

	Self-regulated learning ability r(p)	Self-efficacy in clinical practice r(p)	Instructor–student interaction r(p)	Student–student interaction r(p)	Learning motivation r(p)	Learning Flow r(p)
Self-regulated learning ability	1					
Self-efficacy in clinical practice	.26 ($<.001$)	1				
Instructor–student interaction	.37 ($<.001$)	.15 ($<.001$)	1			
Student–student interaction	.32 ($<.001$)	.085 (.183)	.50 ($<.001$)	1		
Learning motivation	.62 ($<.001$)	.25 ($<.001$)	.50 ($<.001$)	.39 ($<.001$)	1	
Learning Flow	.43 ($<.001$)	.28 ($<.001$)	.25 ($<.001$)	.18 (.006)	.43 ($<.001$)	1

Table 4 Factors affecting the subject's learning flow (N = 245).

	B	SE	β	t	p	Cumulative Adj-R ²	Change in Adj-R ²
Constant	1.04	.24		4.32	$<.001$	-	
Self-regulated learning ability	.19	.06	.24	3.36	.001	.187	.187
Self-efficacy in clinical practice	.27	.08	.23	3.27	.001	.231	.043
Learning motivation	.06	.02	.14	2.49	.014	.255	.024
Combining recorded lectures and real-time video lectures	.13	.06	.13	2.31	.022	.271	.016

Note. Durbin-Watson = 1.969; F = 22.30; $p < .001$; R² = .271; Adj-R² = .259. Tolerance = .603–.967; VIF = 1.034–1.659. Reference group: Real-time video lectures.

[19] study. These findings suggest that nursing students, who were initially perplexed by the sudden onset of virtual classes as a result of COVID-19, subsequently adapted to use digital devices and adjusted to virtual learning.

Participants mentioned that the advantages of virtual lectures, which are beneficial to learning flow, are not only that students can choose the desired learning time and place but that this also provides the opportunity for repeated learning. The most significant advantage of this repeated learning from virtual courses is that they can be accessed at any time and from any location [37]. The flexible nature of such learning can benefit students' learning flow; even after the COVID-19 situation, the advantages of virtual classes can be further extended to and adopted into the curriculum.

Students in this study experienced a decrease in learning flow if the virtual learning environment was not smooth, for example, if disconnections occurred due to simultaneous connections. The technical problems arising during online programs are a key factor in the decrease in university students' concentration and learning motivation [38]. Further, participants believed that the number of assignments increased during virtual lectures and that using digital devices for an extended period of time increased fatigue and decreased learning flow. To enhance students' learning flow, instructors should select assignments of appropriate difficulty and quantity based on their students' learning levels so that learning does not become a burden.

Some students' sleep patterns were disrupted because of their irregular lifestyles. Due to the COVID-19 pandemic, 90.0% of medical students who continued to learn online in a constrained space experience changes in sleep habits and sleep distancing, leading to increased depression, anxiety, and fear of COVID-19 [39]. Various intervention programs, such as eye yoga exercises, can alleviate the physical exhaustion associated with virtual learning [40].

The most significant factor that influenced learning flow in this study was the respondent's self-regulated learning ability, with an average score of 3.60 ± 0.65 out of 5, or greater than the median level. This is slightly higher than the self-regulated learning ability

score of 3.49 measured in the study by Park et al. [41] on nursing college students before COVID-19.

Participants noted that poor self-regulated learning occurred because they delayed virtual learning time, or they did not concentrate in class because they thought they could listen to the lecture again later. For managing to learn effectively and efficiently, students who tend to postpone virtual lessons may benefit from using a schedule management app. Students feel as if they are attending a one-to-one class with the instructor when the professor's face is visible in the video [42]. Instructors should show their faces when video recording classes or using a cloud-based peer-to-peer software platform such as Zoom or Webex to increase students' concentration.

Learning motivation was the second most important factor affecting learning flow in this study. The student participants' average learning motivation score was 3.20 ± 0.44 out of 5. When compared with the score of 3.18 of 5 from Kim and Park's [43] study on college nursing students before COVID-19, the difference was not significant. When using various teaching methods, participants stated that they were completely immersed in their learning. On the other hand, these students also stated that if the class felt insincere or the video lecture was too long, their motivation to learn decreased, and they became bored. Passive learning situations, in which instructors talk without interacting with the students, make it difficult for the listener to maintain concentration for a long time [44]. Various strategies, such as having a quiz during class, are needed to increase students' motivation for learning in online settings. Previous research has found that students prefer video lengths of around 10 minutes for learning content [45]. It is necessary for instructors to organize the lectures into several short videos rather than combining them into one long video so as to reduce the burden on the learners and motivate learning.

Clinical self-efficacy in practice was the third factor affecting learning flow. The average clinical self-efficacy score of this study's student participants was 7.78 ± 1.28 out of 10. This score was comparable to Kim's [46] study of nursing college students prior to

Table 5 Qualitative research results.

Categories	Subcategories	Meaningful statements
A lack of preparation in the start of virtual classes due to the COVID-19 pandemic	Inadequate communication network, equipment, and facilities for virtual classes	"Internet connection was suddenly lost during the lesson and I could only rejoice after a long time had passed. I was worried that I might have missed something important during the time I lost connection." (Participant 3 in Group 4)
	Limited learning skills for virtual classes	"Since it is virtual learning, it seems like more assignments are given out maybe out of fear that students might not study as hard. As assignments were of quantity rather than quality, the motivation to study dropped and not much time was left to study for the actual tests (because of the assignments)." (Participant 1 in Group 1)
Adapting and growing in a new learning environment	Capable of choosing the best time and place to study in enhancing concentration	"I liked the fact that as long as I had either a laptop or a tablet, or even just a smartphone, I could attend and listen to a lecture whenever and wherever I wanted without having to go to the lecture room." (Participant 3 in Group 2)
	Easy to repeat learning using recorded video	"In face-to-face, there was no way for me to catch up whenever I missed some part during the lecture. In contrast, even if I miss something during the lecture, I can now always pause, replay the missed part, and fully understand the part before moving on." (Participant 4 in Group 4)
	Striving to figure a good virtual learning method for oneself	"I tried to summarize and review everything thoroughly. I attempted to create my own schedule management method." (Participant 3 in Group 2)
	Capable of active participation in class through interactions with professors and students Boost student interaction utilizing video teleconferencing platforms (e.g. Zoom)	"I could concentrate better in a virtual lecture if the professors prepare quizzes or various videos related to the class." (Participant 4 in Group 4) "In virtual classes, it was convenient to gather in small-scale conference rooms where we could instantly find and share materials using our own computers." (Participant 2 in Group 3)
Enhancing nursing knowledge and skills through virtual clinical training	In-depth understanding of the case through online learning	"I was satisfied with being able to more to proactively try out performing various medical treatments, improving their problem-solving skills using imaginary scenarios through case studies." (Participant 4 in Group 3)
	Gaining confidence through repeated learning to solve nursing problems on one's own in a safe online environment	"I liked how I tried to solve the problem by myself from beginning to end using virtual practice. I was reminded of the overall procedures of nursing performance evaluations and their significance in building confidence in the entire nursing process." (Participant 3 in Group 3)
	Propose on virtual clinical training as a prerequisite for clinical practice	"Rather than directly going into clinical training at the hospital from the beginning, it was better to first experience the virtual clinical training which induced greater interests in learning." (Participant 1 in Group 3)
Self-regulation difficulties when studying alone due to social distancing	Putting off watching the class video at the scheduled time	"At first, I was following the timetable schedule faithfully but later found myself subsequently falling behind schedule." (Participant 4 in Group 1)
	Extending learning time because of the pressure to learn on one's own	"I listened to it over and over again in an anxious mind. I was concerned that I would miss something important while studying alone. I thought I should miss not even a single point and this pressure made me listen to a 2-hour lecture for more than 3 hours." (Participant 2 in Group 2)
Difficulty concentrating when learning online	Reduced concentration on learning as a result of an irregular lifestyle	"I studied late at night when I could concentrate well. As a result of my morning oversleep, my life became erratic. When there was a real-time Zoom class in the morning, it could be difficult to focus." (Participant 3 in Group 1)
	Loss of concentration in video classes as a result of thinking about listening again	"I often found it difficult to concentrate in class because I could listen to the recorded video later." (Participant 4 in Group 1)
	Variation in learning concentration depending on the professor's learning method and subject preference	"Even if the lecture was long, I would concentrate interesting subjects. But I lost concentration in virtual classes if it was boring or of relatively low importance" (Participant 2 in Group 2)
Disadvantage of virtual learning	Physical fatigue caused by excessive usage of digital devices	"Even in class, I had to look at my laptop, and even when I was doing my homework, I had to do it on my laptop, so it took a toll on my eyes. That, I believe, is why I felt more tired." (Participant 4 in Group 1)
	Burden in asking instructors questions in video lectures	"It was difficult to ask questions because I was afraid of disrupting the flow of the class if I ask a question during Zoom lectures." (Participant 1 in Group 2)
	Communication problems between learners during cooperative learning	"When having a group discussion with other students, it could be difficult to have an active discussion because the other person's microphone could not be heard well or the video function was not working properly." (Participant 2 in Group 5)
Concerns about academic performance	Doubts about academic accomplishments	"In hospital clinical training, we could observe and learn from how the nurses interact with patients when the patients make a request or ask questions. However, the interaction in the online practice platform was disappointing because we only had to ask pre-programmed questions and answers." (Participant 2 in Group 2)
	Concerns about having the ability to cope in a clinical situation	"Nursing students are suddenly unable to practice in the hospital due to the COVID-19. I'm concerned that getting a job will disrupt it. I'm also worried about my ability to function properly as a new nurse." (Participant 1 in Group 3)
Missing opportunities to enjoy college life	Inability to use the college's academic facilities properly due to social distance	"Due to COVID-19 social distancing measures, reading rooms were closed down, preventing their usage. Hence, by being cooped up studying only in my room all day, I felt my learning efficiency dropping." (Participant 4 in Group 2)
	Limiting the scope of human relationships due to a lack of access to classmates	"I am truly sorry that COVID-19 has resulted in the cancellation of school events and club activities, as well as fewer opportunities to interact with other students." (Participant 1 in Group 5)

COVID-19, or 7.77 out of 10 points. Eventually, researchers will need to determine how much practice at nursing colleges during COVID-19 has affected clinical self-efficacy in practice.

One of the most difficult issues involves finding a substitute for clinical practice at a time when face-to-face clinical practice is rendered infeasible due to COVID-19. This is because clinical

practice is important for students to gain their professional certifications in nursing college or medical school. In this study, nursing college students who experienced virtual clinical practice experienced a more in-depth understanding of specific diseases although they had not met patients face-to-face. They also experienced improved theoretical knowledge and gained an understanding of nursing procedures and core, basic nursing skills. Some participants wished to attend a virtual lecture that preceded clinical practice at the hospital. Despite the fact that it is a virtual practice, the students feel as if they have become nurses [2]. Students can strengthen their nursing competency, such as their critical thinking and problem-solving skills, after experiencing clinical practice through a virtual reality simulation (vSim® for Nursing) [47]. It is necessary to construct an environment most similar to the clinical practice settings, with a program that can provide a substitute for the students' clinical practice experience, as well as research on the effectiveness of using a variety of types of virtual content in education.

In the case of non-Korean-translated programs, such as vSim® for Nursing, students in this study encountered difficulties due to foreign languages, and some contents were difficult to understand because they differed from the Korean healthcare system. It may be difficult to focus in classes involving psychiatric scenarios, in which patient communication is crucial. Thus, it is necessary to develop a program that reflects the Korean healthcare context for safe and efficient virtual clinical practice.

The students in this study were also concerned that the sudden pauses in the hospital clinical practices from COVID-19 would prevent them from attaining sufficient clinical skills. Opportunities for clinical practice in the field had become increasingly scarce for nursing students even before COVID-19 due to the quantitative expansion of the nursing department's student intake and an increase in consumers' rights in the medical field in Korea [48]. Hence, highly effective and efficient virtual and specialized clinical training programs must be developed for instances in which it is difficult to conduct clinical practice virtually.

Even though the instructor-learner interaction exhibited a positive correlation with learning flow, this factor had no major impacts. Some participants felt burdened by asking questions of their instructors during video lectures, and it was difficult to communicate with instructors who were inexperienced in using digital devices. Instructors must communicate with students in various ways during virtual situations to increase the frequency of interactions and help to immerse them in learning. For example, instructors can use a chat window during the lecture or administer a quiz to review students' understanding of the class.

Student–student interaction positively correlated with learning flow, but this factor did not have a major impact. Students expressed that using various convenient features available on video conferencing platforms facilitated communication between students. Participants also reported communication issues between learners during cooperative learning and stated that it was difficult to study alone without the company of other students. Further, student interaction decreased as a result of the reduction in school events. In Ahn's [49] study, students feel “the burden of facial exposure” and “the long time it took to decide on something with team members” during virtual cooperative learning. To ensure smooth communication between learners during these virtual classes, instructors must provide clear guidelines for cooperative learning and offer appropriate feedback while monitoring the learning process.

Nursing students in this study struggled to “find suitable places and facilities to study” because the school facilities were closed due to COVID-19. Despite the tightening “social distancing” measures, students' need to study is also critical. Consequently, schools must continue to consider and apply the best ways to allow students to

use at least some of the campus learning spaces without violating the rules of social distancing.

This study also includes some limitations. First, only nursing college juniors and seniors from a variety of locations in the Republic of Korea were examined. Second, because the curricula and teaching methods applied at each of the three nursing institutions differed, it is difficult to generalize the research findings. Finally, due to the COVID-19 quarantine, focus group interviews with five groups were conducted face-to-face for one group, and video conferencing platforms were used for the remaining four groups. Thus, all the group interviews could not be conducted in the same setting, potentially leading to discrepancies in the research findings.

Conclusion

This study's results reveal that for nursing college students to increase their learning flow in the learning situations caused by the COVID-19 pandemic, measures should be devised to improve their self-regulated learning ability, learning motivation, and clinical self-efficacy in practice. Further, this survey's student respondents favored the mixed-lecture format or a combination of recorded and real-time video lectures.

On the one hand, the nursing student respondents attempted to use online learning to develop their own learning expertise. These students were concerned that if the virtual clinical practice continued, they would be unable to fully establish their competence to work as real hospital nurses. Intervention studies to minimize student weariness are needed for more effective and efficient virtual learning.

For teachers to conduct efficient virtual lectures, it is also necessary to provide relevant education and assistance in teaching strategies at both the school and state levels. It is also critical to develop learning materials and tools for virtual clinical practice custom-tailored to the South Korean clinical setting for specialized areas in which clinical training is typically difficult, such as neonatal intensive care units and delivery departments.

Conflict of interest

The author declared no conflict of interest.

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