



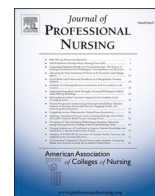
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Academic Success of Online Learning in Undergraduate Nursing Education Programs in the COVID-19 Pandemic Era

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ABSTRACT

Background: This study aimed to investigate predictors for academic success, including satisfaction with online class and academic achievement, in the coronavirus disease 19 (COVID-19) pandemic era.

Purpose: To obtain basic data needed to improve the quality and outcomes of online learning in lectures for nursing students.

Method: A cross-sectional, descriptive, nationwide online survey in South Korea was performed using structured questionnaires. Participants were 200 nursing students taking online-based learning at universities in 2020. Data were analyzed using descriptive statistics and hierarchical multiple regression with SPSS WIN 26.0 program.

Results: Cyber-class flow ($\beta = 0.65, p < 0.001$) was a significant predictor of satisfaction with online class. Self-directed learning ($\beta = 0.18, p = 0.014$) and satisfaction with online class ($\beta = 0.19, p = 0.035$) were significant predictors of academic achievement.

Conclusion: To achieve academic success from online learning, self-directed learning should be prioritized and satisfaction with online class needs to be managed by nursing educators. To improve satisfaction with online class, cyber-class flow should be considered when designing teaching and learning methods for undergraduate nursing education programs.

Introduction

Coronavirus disease of 2019 (COVID-19) (WHO, 2021a) was first reported in December 2019. Since early January 2020, when the World Health Organization (WHO) confirmed the first case, the number of cases has been steadily increasing. The cumulative number of confirmed cases exceeded 221 million by September 7, 2021 (WHO, 2021b). Thus, the WHO declared the COVID-19 outbreak a global pandemic and urged all countries to establish national-level emergency response systems to fight the crisis (WHO, 2020). As of September 2021, the number of deaths had risen to 4.5 million (WHO, 2021b). Vaccines tested for efficacy and safety are being administered in 2021 (WHO, 2021a). The situation in Korea was the same. The Korean government compelled citizens' proactive participation through social distancing and distancing in everyday life for preventing COVID-19 from spreading (Ministry of Health and Welfare, 2020). Accordingly, it is difficult for many people to leave home. Schools discontinued in-person classes. Currently, COVID-19 takes a great toll in all domains of human life (Shin, 2020). Some people even forecast that there will be a new

historical divide associated with the time Before Corona (BC) and the time After Corona (AC) (Friedman, 2020).

The field of education did not escape the impact of COVID-19 either. Globally, experts in online learning recognize that aspects of online learning experience differ from those of face-to-face teaching. They have attempted to cope with the challenge (Adedoyin & Soykan, 2020; Rapanta, Botturi, Goodyear, Guàrdia, & Koole, 2020). The importance of technology in online learning, including information and communication technology, has also emerged (Adedoyin & Soykan, 2020; Ali, 2020). In Korea, too, the start of school was postponed in March 2020 for all preschools, kindergartens, elementary, middle, high schools, and special schools. Colleges and universities were also recommended to administer classes online, in a similar fashion to remote classes primarily provided by cyber universities, in lieu of classes in group settings at school buildings (Ministry of Education, 2020). As colleges and universities transitioned to administer all classes online, students with the right to learn expressed diverse opinions. Some students even demanded refund of tuition, although educators also went through much difficulties (Yonhap News, 2020).

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In nursing education, quality is crucial for the development of future health care professionals. Hence, the quality of undergraduate nursing education programs in Korea is regulated and ensured via the Accreditation on Baccalaureate Nursing Programs based on outcome-based education (Korean Accreditation Board of Nursing Education, 2017). Graduating students of nursing departments can obtain nursing licenses issued by the Minister of Health and Welfare only if they pass the National Registered Nurses' License Examination (National Law Information Center, 2020). Thus, the content and quality of subjects that nursing students take over the 4-year curriculum are very important (Korean Accreditation Board of Nursing Education, 2017). The impact of COVID-19 is likely to persist for some time. Accordingly, many nursing educational institutions worldwide have switched from face-to-face to online classes (Morin, 2020). At the present time, it seems that online classes will likely become both obligatory and standard. Therefore, a more elaborate and systematic approach is necessary to do this successfully (Morin, 2020). Accordingly, it is necessary to evaluate these rather impromptu online classes for nursing education, which had to be offered in 2020 with no time for preparation due to COVID-19 outbreak. It is also necessary to design future online courses based on assessments that will positively influence the quality of nursing education in the future.

Due to characteristics of nursing education which has an emphasis on face-to-face classes to develop nursing professionals, most previous studies on online or cyber classes have been performed in fields other than nursing (Lee, 2013; Lee & Kim, 2018; Rasheed, Kamsin, & Abdullah, 2020; Shin, Kim, & Kim, 2005; Sung, Chae, & Lee, 2019). Student outcomes such as academic achievement (Chei & Lee, 2017; Park, Lee, & Bae, 2010) and satisfaction (Joo, Kang, & Lim, 2016; Kwon, Han, Lee, & Bhang, 2012; Lee, 2013; Richardson, Maeda, Lv, & Caskurlu, 2017) have been actively studied. Research studies have also been conducted to identify factors influencing academic achievement and satisfaction. As major influential factors, students' self-directed learning (Khalid, Bashir, & Amin, 2020; Sung, Chae, & Lee, 2019), flow (Özhan & Kocadere, 2020; Shin, Kim, & Kim, 2005), and obstacles (Lee, 2013) have been investigated. Self-directed learning can be defined as the mode of learning in which students who establish their own study goals and strategies are accountable for outcomes (Ku, Yang, & Choi, 2013). Flow is defined as a state in which individuals are so deeply engaged in the current activity that they do not pay attention to other activities or the passage of time (Mihaly, 2004). Regarding students' engagement, similar concepts such as learning flow (Park, 2017) and cyber-class flow (Shin, Kim, & Kim, 2005) have been studied. With respect to online classes, however, the concept of cyber-class flow is generally believed to be more appropriate than the learning flow. Obstacles refer to online learning obstacles recognized by learners participating in online classes in the class environment and class activities (Lee, 2013). Satisfaction of this study evaluated the overall satisfaction with online learning, including lecture contents, learning system, and instructor activities (Kwon, Han, Lee, & Bhang, 2012). In the field of nursing, studies have examined online classes for clinical practicum and online- and offline-blended learning in classroom lectures (Lu, Lin, & Li, 2009; Park, Lee, & Bae, 2010) to some extent. However, studies investigating the satisfaction and outcomes of classroom lectures administered through online learning during the whole period of a semester have not been reported to the best of our knowledge. Since the COVID-19 pandemic is persisting, studies examining the impact of online class for undergraduate nursing students started to emerge, including those on satisfaction (Kim, Kim, Oh, & Jung, 2020) and learning flow (Lim & Yeom, 2020).

Because online classes, which include either watching video lectures or attending real-time video class meetings, are relatively unrestricted in terms of time and space, individuals can proactively steer the learning environment. Accordingly, as ultimate agents in an online class, students are required to have a self-directed ability to learn on their own. In addition, factors relevant to computer- or internet-related obstacles should be identified because students have to use class content delivered via the internet. However, few studies have examined self-directed

learning, obstacles to online learning, satisfaction, and cyber-class flow in nursing students taking online classes.

Thus, the purpose of this study was to obtain basic data needed to improve the quality and outcomes of lectures offered via online classes for nursing education. Specific objectives of this study were: 1) to assess self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online classes, and academic achievement of study participants; 2) to examine differences in self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online classes, and academic achievement according to participants' general characteristics, such as age, gender, grades of students, computer certificate, ability to use computers, ability to search for information via internet, the number of lectures taken via online classes during first semester 2020, past experience of online class, administrative districts of nursing schools, and types of universities; 3) to investigate correlations between self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online classes, and academic achievement in study participants; and 4) to identify factors influencing satisfaction with online classes and academic achievement in study participants.

Subjects and methods

Design

This research was a cross-sectional, descriptive correlational study conducted to assess satisfaction with online class and academic achievement in students who took lectures via online learning offered as a regular course by the Department of Nursing at universities during the first semester from March to June and to identify factors influencing satisfaction with online classes and academic achievement. To collect data, a self-reporting online survey questionnaire was used.

Sample

The target population of this study were undergraduate nursing students. Accessible population were undergraduate nursing students attending a 4-year university in Korea who were able to participate in an online survey. Specific inclusion criteria were: (1) students who were attending the Department of Nursing in a 4-year university located in Korea, (2) those who had officially registered for lectures for nursing education in the first semester of 2020 and completed online class for at least one regular course, and (3) those who voluntarily provided consent to participate in this study after they had been informed of the study's purposes. Those who did not take an online class for nursing education in the first semester of 2020 were excluded. The sample size was estimated using G*Power 3.1.9.2 (Faul, Erdfelder, Buchner, & Lang, 2009) after applying parameters for regression analysis. Based on the finding of a meta-analysis conducted on cyber university students in Korea (Joo, Kang, & Lim, 2016) that the overall effect size in correlations between endogenous factors relevant to learning satisfaction (i.e., learning psychology, learning competency, and learning attitude) had a medium value of 0.39 (Cohen, 1977), the following assumptions were made: medium effect size (f^2) of 0.15, power ($1 - \beta$) of 0.90, significance level (α) of 0.05, and 14 independent variables (age, gender, grades of students, computer certificate, ability to use computers, ability to search for information via internet, the number of lectures taken via online classes during first semester 2020, past experience of online class, administrative districts of nursing schools, and types of universities, self-directed learning, cyber-class flow, obstacles to online learning, and satisfaction with online classes). The minimum number of participants was estimated to be 166 based on these assumptions. Data were collected from a total of 203 participants in consideration of a drop-out rate of 20% given that data were collected through an online survey.

Procedures

Data were collected using a structured questionnaire by administering it online between August 10, 2020 and August 18, 2020. To prevent contact between the researcher and participants, a third person without conflicts of interest with students (a research assistant) informed students (potential study participants) about the study and asked them to voluntarily participate. Notices for recruiting research participants and QR code or the link to the online survey were released via internet and SNS. Furthermore, snowball sampling was performed to enable participants to introduce this study to other potential participants during the process of data collection. Snowball sampling was considered as a method of open-half interval to reduce undercoverage of the population. Among students who saw the notice for recruiting research participants, only nursing students who met the inclusion criteria and wanted to voluntarily participate in this study participated in the online survey and answered questions. Participants responded anonymously to the questionnaire. In addition, we did not forcefully recommend participation of students of the university to which this researcher belongs. Even if they did not participate in this study, they did not receive any penalty. A total of 203 online surveys were completed and a total of 200 (98.5%) were submitted for analysis after three of them were discarded due to incomplete responses.

Measures

For all scales used in this study, permission to use was obtained from the original authors and any researchers responsible for revised versions of scales. These scales used in this study were not originally developed for nursing students. Therefore, we performed a factor analysis or modified items to improve the validity and reliability of these scales for nursing students. In addition, to increase coherence of the answer of a variable, the guideline “Please take part in the survey by recalling [one specific lecture taken online learning] among the various lectures of nursing department in this first semester 2020” was provided before answering the questionnaire.

General characteristics

For demographic characteristics, the following 10 items were included based on literature review: age, gender, grades of students, computer certificate, ability to use computers, ability to search for information via internet, the number of lectures taken via online classes during the first semester of 2020, past experience of online class, administrative districts of nursing schools, and types of universities. Grades of students were categorized into 1st, 2nd, 3rd, and 4th graders and marked on respondents' grades. The presence or absence of a computer license and past experience of online class were categorized as yes or no. Regarding the ability to use computers and the ability to search for information via internet, participants self-assessed their abilities using the analog scale method with 0 meaning “I absolutely cannot do.” to 10 meaning “I am very confident.” The higher the score, the higher the ability. The number of lectures via online classes which students had registered in the first semester of 2020 was written. Nursing colleges in which respondents were enrolled were categorized according to administrative districts of the Republic of Korea. Types of universities were categorized into national universities, public universities, and private universities.

Self-directed learning

A Scale developed by Sung, Chae, and Lee (2019) was modified and used to measure self-directed learning. The original scale consisted of a total of ten 4-point Likert scale items. To test the scale's validity, an exploratory factor analysis was conducted. The number of factors was set to be one, the same number as that when the scale was developed. To test for sample fitness to factor analysis, Kaiser–Meyer–Olkin (KMO) and Bartlett's sphericity tests were performed with significant ($p < 0.001$)

results, confirming that the data were fit for factor analysis. To extract factors, principal component analysis with varimax rotation was performed. The analysis showed that the factor loading of Item 1 “I think studying is the most productive and valuable activity and more important than other activities” was <0.40 (0.18). Thus, Item 1 was removed in accordance with the statistical suggestion (Yeo, 2006). The explanatory power of the remaining nine items, Items 2–10, was 28.32%. Finally, a modified scale with a total of nine items was used in this study. Each item was on a 4-point Likert scale where 1 meant “never” and 4 meant “highly likely”, with higher score indicating higher level of self-directed learning. Regarding internal consistency reliability, Cronbach's alpha was 0.84 in the study Sung, Chae, and Lee (2019). It was 0.67 in this study.

Cyber-class flow

To assess cyber-class flow, a modified version scale developed by Shin, Kim, and Kim (2005) was used. The original scale consisted of 22 five-point Likert scale items across a total of five domains (five items in enjoyment, five in telepresence, four in focused attention, four in engagement, and four in distortion of time). Before exploratory factor analysis was performed on the original scale for validity testing, the KMO and Bartlett's sphericity test were conducted to determine the fitness of the data for factor analysis. Results were significant ($p < 0.001$), confirming data fitness. Principal component analysis with varimax rotation was performed by setting the number of factors to be five, the same number as that used in the original scale. After the analysis, two items (Items 21 and 22) were removed because they lowered item reliability or had a negative factor loading. A second round of factor analysis was performed for the remaining 20 items by setting the number of factors to be five. Results showed that the internal consistency reliability was <0.60 for two factors. Thus, the number of factors was modified to be four in the third round of factor analysis. Results of this analysis showed all eigenvalues >1.0 , all factor loadings >0.40 , and a total variance of 56.92%. Accordingly, a modified version of the original scale was used in this study, which consisted of a total of 20 items across four factors (six items in enjoyment, six in focused attention, three in telepresence, and five in engagement and interaction). These items were rated on a 5-point Likert scale in which 1 meant “never” and 5 meant “highly likely,” with a higher score indicating a higher level of cyber-class flow. In a study by Shin, Kim, and Kim (2005), the Cronbach's alpha value by factor was 0.81 for enjoyment, 0.63 for telepresence, 0.83 for focused attention, 0.82 for engagement, and 0.73 for distortion of time. In this study, the Cronbach's alpha value for the entire scale was 0.87 and the Cronbach's alpha value by factor was 0.86 for in enjoyment, 0.84 for focused attention, 0.67 for telepresence, and 0.60 for engagement and interaction.

Obstacles to online learning

To assess obstacles to online learning, a modified version of the scale developed by Lee (2012) was used. Lee (2012) initially developed 26 items and proposed 22 items across seven factors in a subsequent study (Lee, 2013), in which factor analysis was performed on the data collected from undergraduate students taking online classes. Specifically, the scale of 22 items had five items for lack of social presence, four for computing environment instability, three inadequacy for learning environment, two items for difficulty in peer interaction, four items for lack of information processing self-efficacy, two items for learning burden, and two items for limited interaction with the teacher (Lee, 2013). Exploratory factor analysis to test for the validity was conducted for 27 items, which included the initial 26 items in Lee (2012) and an additional item in the factor of limited interaction with the teacher, “I wonder whether the teacher will respond to my questions promptly,” as suggested by the developer of the scale. KMO and Bartlett's sphericity tests were performed with significant ($p < 0.001$) results, confirming data fitness for factor analysis. To extract factors, principal component analysis with varimax rotation was performed.

First, the number of factors was set to be seven for the total of 27 items, the same number of factors used in the original scale. Results showed that the reliability with two factors was <0.60 . Thus, a second round of factor analysis was performed by setting the eigenvalue to be 1.0. As a result, five factors were extracted. After two items (Items 11 and 12) in the fifth factor with reliability <0.60 were removed, a third round of factor analysis was performed for 25 items. In this round, one item (Item 27) had a factor loading <0.40 and another item (Item 21) did not belong to any of the extracted factors. Thus, a fourth round of factor analysis was performed for a total of 23 items after Items 21 and 27 were removed. Results of this analysis showed all eigenvalues >1.0 , all factor loadings >0.40 , and a total variance of 59.16%. Accordingly, the modified version of the scale used in the study consisted of a total of 23 items across four factors (eight items for lack of online interaction and information processing self-efficacy, five for lack of social presence, five for computing environment instability, and five for learning burden). Each item was based on a 5-point Likert scale, where 1 meant “never” and 5 meant “highly likely”, with a higher score indicating more severe obstacles to online learning. In a study by Lee (2013), the Cronbach’s α of the scale with a total of 22 items was 0.90. In this study, the Cronbach’s α of the modified scale with a total of 23 items was 0.92.

Satisfaction with online classes

Satisfaction with online classes was assessed using a modified version of the scale revised by Kwon, Han, Lee, and Bhang (2012) from the cyber university course evaluation scale developed by Joo, Kim, and Cho (2008). The scale consisted of a total of 21 items across four domains (eight items in the domain of video watching and web-based learning activity, five in lecture, four in learning system, and four in faculty activity). In this study, a total of 18 items were examined in exploratory factor analysis by adding one additional item “I would like to take online classes in the future, too, if an opportunity is presented” to the original scale with 17 items based on results from the content validity test by experts. To perform exploratory factor analysis for the purpose of validity testing, KMO and Bartlett’s sphericity tests were conducted first to examine the fitness of data for factor analysis. Results were significant ($p < 0.001$), confirming data fitness for factor analysis. In the factor analysis, the number of factors was set to be four, the same number as in Kwon, Han, Lee, and Bhang’s (2012) scale. All eigenvalues were > 1.0 and the total variance was 62.94%. However, one item (Item 8) had a community <0.50 , reducing reliabilities of the entire set of items and the factor to which the item belonged. Hence, the item was removed and a second round of factor analysis was performed for the remaining 17 items by setting the number of factors to be four. In this analysis, all eigenvalues were > 1.0 , all factor loadings were at least 0.40, and the total variance was 65.97%. Each item was based on a 5-point Likert scale where 1 meant “not at all,” 5 meant “highly likely,” with a higher score indicating a higher level of satisfaction with online class. The Cronbach’s α of the original scale was 0.96 in Joo, Kim, and Cho (2008). In this study, the Cronbach’s α of the modified scale was 0.89.

Academic achievement

To assess academic achievement, participants were instructed to select one of the lectures taken via online class in the first semester of 2020 and self-assess academic achievement in lectures by assigning a score of 0 to 100. The higher the score, the higher the self-assessed academic achievement.

Data analysis

Data analysis was performed using SPSS WIN 26.0. To analyze participants’ general characteristics and measurement variables, frequencies, percentages, means, and standard deviations were computed. Differences in self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online class, and academic achievement

according to differences in participants’ general characteristics were examined by performing independent t -test and one-way analysis of variance, followed by post-hoc analysis using the Scheffé test. If the assumption of homogeneity of variances was not met based on an equal variance test, Welch’s test for unequal variances was performed and Games–Howell test was used for post-hoc testing. To examine correlations between self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online class, and academic achievement, Pearson’s correlation coefficients were computed. To identify factors influencing satisfaction with online class and academic achievement, hierarchical multiple regression analysis was performed. Furthermore, Cronbach’s α coefficients were computed to examine the internal consistency reliability of the scales. Exploratory factor analysis was performed to test for validity. In all analyses, statistical significance was considered at $p < 0.05$.

Ethical consideration

This study was approved by the Jeonbuk National University Institutional Review Board (IRB) (JBNU 2020-06-014-001). The researcher sent students who saw the subject recruitment announcement and wanted to participate a QR code or online link to fill out the online survey. Prior to data collection, a consent form was displayed in the first screen of the online survey to inform participants of study purposes, confidentiality, their rights not to respond to the survey, and to withdraw from the study at any time. Participants who consented to study participation were able to fill out the survey after signing the consent form first. Personal information needed to send a gift to compensate for their time was collected using a separate link. A mobile coupon to redeem at a convenience store was sent to participants who provided contact information. The researcher made every effort to protect participants’ personal information by deleting their contact information after the coupon was sent. For anonymization, an ID number was assigned to each survey, research data were coded only in a single predetermined place (the researcher’s lab), and coded data were saved in a secure file with a password accessible only to the researcher. Personal information was completely removed from the research data. Once all analyses were complete, data were sealed. They will be stored by the researcher for a maximum of three years. Once study findings are presented, data will be disposed of following the IRB’s procedure.

Results

Participants’ general characteristics

The mean age of participants was 21.70 years. The majority (86.5%, $n = 173$) of participants were females. Regarding their grades, 33.0% ($n = 66$) were in second grade, 33.5% ($n = 67$) in third grade, and 33.5% ($n = 67$) in fourth grade. The mean score for their ability to use computers was 6.93 and the mean score for their ability to search for information via internet was 7.97. Participants took an average of 5.51 online classes for lectures in the first semester of 2020. The area in which the administrative districts of nursing schools was located was classified as other cities and provinces for the largest group of participants (62.5%, $n = 125$). The most common type of universities was national/public university (68.0%, $n = 136$) (Table 2).

Levels of self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online classes, and academic achievement

The mean score for subjective perception of self-directed learning was 3.03 ± 0.36 out of 4 points. The mean score of cyber-class flow was 3.37 ± 0.52 out of 5 points. The mean score for obstacles to online learning was 2.92 ± 0.70 out of 5 points. The mean score for satisfaction with online class was 3.71 ± 0.52 out of 5 points, and mean score for academic achievement was 78.03 ± 13.78 out of 100 points (Table 1).

Table 1

Descriptive statistics for self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online class, and academic achievement (N = 200).

Variable	Categories (total number of items)	Range	Mean ± SD	Skewness	Kurtosis
Self-directed learning (9)		1–4	3.03 ± 0.36	0.00	−0.44
Cyber-class Flow (20)		1–5	3.37 ± 0.52	0.15	0.29
Enjoyment (6)		1–5	3.49 ± 0.69	−0.40	0.51
Focused attention (6)		1–5	3.03 ± 0.78	0.18	−0.25
Telepresence (3)		1–5	4.06 ± 0.60	−0.36	−0.32
Engagement and interaction (5)		1–5	3.21 ± 0.65	0.04	0.06
Obstacles to online learning (23)		1–5	2.92 ± 0.70	−0.27	0.12
Lack of online interaction and information processing self-efficacy (8)		1–5	2.34 ± 0.83	0.23	−0.46
Lack of social presence (5)		1–5	3.05 ± 0.90	−0.22	−0.19
Computing environment instability (5)		1–5	3.32 ± 0.99	−0.33	−0.42
Learning burden (5)		1–5	3.30 ± 0.82	−0.55	0.52
Satisfaction with online class (17)		1–5	3.71 ± 0.52	−0.20	0.15
Satisfaction with lecture contents and teaching methods (7)		1–5	3.86 ± 0.55	−0.24	0.22
Overall satisfaction and lecture loyalty (3)		1–5	3.56 ± 0.89	−0.51	−0.09
Satisfaction with faculty activity (4)		1–5	3.85 ± 0.59	−0.54	1.37
Learning system satisfaction (3)		1–5	3.32 ± 0.84	−0.05	−0.52
Academic achievement mean		0–100	78.03 ± 13.78	−1.122	1.985

SD = standard deviation of the mean.

Self-directed learning, cyber-class flow, obstacles to learning, satisfaction with online classes, and academic achievement according to general characteristics of participants

Subjective perception of self-directed learning showed statistically significant differences according to gender, ability to use computers, and ability to search for information via internet (all $p < 0.05$). Subjective perception of cyber-class flow showed statistically significant differences according to ability to use computers and ability to search for information via internet (both $p < 0.05$). Obstacles to online learning were statistically different according to age, grades of students, ability to use computers, and ability to search for information via internet (all $p < 0.05$). Post-hoc analysis (Scheffé test) found that the perceived level of obstacles to online learning was lower in the fourth grade than in second and third grades. Satisfaction with online classes showed statistically significant differences according to ability to use computers, ability to search for information via internet, administrative districts of nursing schools, and types of universities (all $p < 0.05$). Post-hoc analysis (Scheffé test) showed that the level of satisfaction with online class was higher in participants attending an administrative districts of nursing schools in other cities and provinces than in metropolitan cities. Self-assessed academic achievement was statistically different according to ability to search for information via internet ($p < 0.05$) (Table 2).

Correlation among self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online classes, and academic achievement

Correlations among variables were shown in Table 3. Satisfaction with online classes showed a weak positive correlation with self-directed learning ($r = 0.19, p = 0.008$), a strong positive correlation with cyber-class flow ($r = 0.69, p < 0.001$), and a moderate negative correlation with obstacles to online learning ($r = -0.32, p < 0.001$). Its relationship with each variable was statistically significant. Academic achievement of nursing students showed moderate positive correlations with self-directed learning ($r = 0.30, p < 0.001$), cyber-class flow ($r = 0.37, p < 0.001$), and satisfaction with online class ($r = 0.35, p < 0.001$). These correlations were statistically significant. In addition, cyber-class flow had a moderate positive correlation with self-directed learning ($r = 0.35, p < 0.001$) and a moderate negative correlation with obstacles to online learning ($r = -0.31, p < 0.001$). These correlations were statistically significant.

Factors affecting satisfaction with online classes

To identify factors influencing satisfaction with online classes, hierarchical multiple regression analysis was performed using variables significantly related to satisfaction with online classes (i.e., ability to use computers, ability to search for information via internet, administrative districts of nursing schools, types of universities, self-directed learning, cyber-class flow, and obstacles to online learning) found in univariate analysis as independent variables. Prior to regression analysis, assumptions of regression analysis with respect to independent variables were tested. It was found that absolute values of correlation coefficients between independent variables were < 0.80 (range, 0.01–0.73), tolerances were > 0.1 (range, 0.23–0.83), and variance inflation factors (VIF) were < 10 (range, 1.20–4.35). Thus, multicollinearity was not an issue. The Durbin-Watson index was computed to examine the autocorrelation of the dependent variable. Its value was 1.87 ($d_U = 1.84 < d < 4-d_U = 2.16$), close to 2 and between d_U (the upper limit) and $4-d_U$, confirming the absence of autocorrelation. Hierarchical regression analysis was performed as follows: 1) administrative districts of nursing schools and types of universities were entered in the first step of hierarchical regression in which exogeneous variables were controlled, 2) ability to use computers, ability to search for information via internet was entered in the second step, and 3) self-directed learning, cyber-class flow, and obstacles to online learning were entered in the third step. Of these variables, administrative districts of nursing schools and types of universities were converted to dummy variables. Significance testing for variables added at each hierarchy level was performed by examining the significance of the adjusted coefficient of determination ($\Delta \text{adj. } R^2$) (Jaccard & Turrisi, 2003). In the first step, when administrative districts of nursing schools and types of universities were entered into the model, they explained 3.4% of the variance of satisfaction with online class ($F = 3.30, p = 0.021$). Administrative districts of nursing schools (Others; $\beta = 0.29, p = 0.042$) significantly influenced the satisfaction with online classes. In the second step, when the ability to use computers, ability to search for information via internet was entered into the model, the model explained an additional 8.0% of the variance of satisfaction with online classes ($\Delta \text{adj. } R^2 = 0.080, p < 0.001$). The ability to search for information via internet ($\beta = 0.34, p < 0.001$) significantly influenced the satisfaction with online class. In the third step, when self-directed learning, cyber-class flow, and obstacles to online learning were entered into the model, the model explained an additional 38.2% of the variance of satisfaction with online classes ($\Delta \text{adj. } R^2 = 0.382, p < 0.001$). In addition, cyber-class flow ($\beta = 0.65, p < 0.001$) was identified as a significant predictor of satisfaction with online classes. The overall explanatory power of the final model in the third step of the

Table 2

Differences of participants' self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online class, and academic achievement (N = 200).

Variable	Categories	n (%) or mean \pm SD	Self-directed learning*		Cyber-class flow		Obstacles		Satisfaction		Academic achievement	
			Mean \pm SD	t or F or r (p) Scheffé test	Mean \pm SD	t or F or r (p) Scheffé test	Mean \pm SD	t or F or r (p) Scheffé test	Mean \pm SD	t or F or r (p) Scheffé test	Mean \pm SD	t or F or r (p) Scheffé test
Age (yr)		21.70 \pm 1.87		-0.10 (0.177)		-0.10 (0.170)		0.17 (0.014)		-0.05 (0.475)		-0.03 (0.653)
Gender	Female	173 (86.5)	3.01 \pm 0.35	-2.35 (0.020)	3.36 \pm 0.49	-0.49 (0.622)	2.93 \pm 0.67	0.36 (0.720)	3.70 \pm 0.51	-0.59 (0.553)	77.87 \pm 13.95	-0.41 (0.684)
	Male	27 (13.5)	3.18 \pm 0.37		3.41 \pm 0.64		2.86 \pm 0.90		3.77 \pm 0.59		79.04 \pm 12.85	
Grades of students	2nd grade ^a	66 (33.0)	3.00 \pm 0.35	0.98 (0.379)	3.35 \pm 0.48	2.12 (0.122)	3.05 \pm 0.64	5.14 (0.007)	3.70 \pm 0.57	1.17 (0.313)	78.02 \pm 13.85	1.47 (0.232)
	3rd grade ^b	67 (33.5)	3.00 \pm 0.34		3.29 \pm 0.50		3.01 \pm 0.65	c < a, b	3.65 \pm 0.50		76.00 \pm 15.75	
	4th grade ^c	67 (33.5)	3.08 \pm 0.38		3.46 \pm 0.55		2.70 \pm 0.76		3.79 \pm 0.49		80.07 \pm 11.26	
Computer certificate	Yes	64 (32.0)	3.08 \pm 0.37	1.50 (0.135)	3.38 \pm 0.52	0.31 (0.756)	2.88 \pm 0.73	-0.60 (0.551)	3.72 \pm 0.53	0.08 (0.933)	77.98 \pm 13.25	-0.03 (0.974)
	No	136 (68.0)	3.00 \pm 0.35		3.36 \pm 0.51		2.94 \pm 0.69		3.71 \pm 0.52		78.05 \pm 14.07	
Ability to use computers		6.93 \pm 1.84 (range 2–10)		0.21 (0.003)		0.17 (0.018)		-0.19 (0.008)		0.14 (0.046)		0.05 (0.449)
Ability to search for information via internet		7.97 \pm 1.63 (range 3–10)		0.35 (<0.001)		0.34 (<0.001)		-0.25 (<0.001)		0.28 (<0.001)		0.28 (<0.001)
Number of online classes		5.51 \pm 1.63 (range 2–11)		0.02 (0.829)		-0.06 (0.374)		0.10 (0.176)		-0.06 (0.434)		-0.01 (0.879)
Past experience of online class	Yes	84 (42.0)	3.02 \pm 0.33	-0.15 (0.879)	3.36 \pm 0.48	-0.08 (0.933)	3.00 \pm 0.68	1.33 (0.186)	3.75 \pm 0.49	0.99 (0.324)	80.05 \pm 11.57	1.77 (0.078)
	No	116 (58.0)	3.03 \pm 0.38		3.37 \pm 0.54		2.86 \pm 0.71		3.68 \pm 0.54		76.57 \pm 15.06	
Administrative districts of nursing schools	Seoul ^a	27 (13.5)	3.11 \pm 0.49	0.48* (0.619)	3.26 \pm 0.51	1.57 (0.211)	3.17 \pm 0.66	2.82 (0.062)	3.65 \pm 0.56	4.90 (0.008)	78.89 \pm 16.54	1.40* (0.255)
	Metropolitan ^b	48 (24.0)	3.02 \pm 0.32		3.30 \pm 0.52		2.99 \pm 0.68		3.53 \pm 0.46	b < c	74.94 \pm 15.12	
	Others ^c	125 (62.5)	3.02 \pm 0.34		3.41 \pm 0.51		2.84 \pm 0.71		3.79 \pm 0.52		79.03 \pm 12.48	
Types of universities	National · Public	136 (68.0)	3.01 \pm 0.35	-1.17 (0.245)	3.38 \pm 0.50	0.59 (0.559)	2.86 \pm 0.71	-1.90 (0.059)	3.77 \pm 0.51	2.31 (0.022)	78.40 \pm 13.22	0.55 (0.584)
	Private	64 (32.0)	3.07 \pm 0.36		3.33 \pm 0.54		3.06 \pm 0.67		3.59 \pm 0.52		77.25 \pm 14.97	

SD = standard deviation of the mean.

a,b,c for Scheffé test.

* Welch test.

hierarchical regression analysis was 48.9% ($F = 24.81$, $p < 0.001$) (Table 4).

Factors affecting subjective academic achievement

To identify factors influencing academic achievement, hierarchical multiple regression analysis was performed using significant variables in

univariate analysis (i.e., ability to search for information via internet, self-directed learning, cyber-class flow, and satisfaction with online classes) as independent variables. Prior to regression analysis, assumptions of regression analysis with respect to independent variables were tested. It was found that correlation coefficients between independent variables were <0.80 (range, 0.19–0.69), tolerances were >0.1 (range, 0.47–0.82), and VIFs were <10 (range,

Table 3
Correlations among self-directed learning, cyber-class flow, obstacles to learning, satisfaction with online class, and academic achievement (N = 200).

Variable	1. Self-directed learning	2. Cyber-class flow	3. Obstacles	4. Satisfaction
	r (p)	r (p)	r (p)	r (p)
2. Cyber-class flow	0.35 (<0.001)			
3. Obstacles	-0.04 (0.548)	-0.31 (<0.001)		
4. Satisfaction	0.19 (0.008)	0.69 (<0.001)	-0.32 (<0.001)	
5. Academic achievement	0.30 (<0.001)	0.37 (<0.001)	-0.10 (0.163)	0.35 (<0.001)

1.92–2.14), confirming that multicollinearity was not an issue. The value of Durbin–Watson index computed to examine the autocorrelation of the dependent variable was 1.92 ($d_U = 1.81 < d < 4 - d_U = 2.19$), which was close to 2 and between d_U and $4 - d_U$, confirming the absence of autocorrelation. Hierarchical regression analysis was performed as follows: 1) ability to search for information via internet was entered in the first step in which exogeneous variables were controlled; 2) self-directed learning and cyber-class flow were entered in the second step, and 3) satisfaction with online classes was entered in the third step. In the first step, the model with ability to search for information via internet explained 7.4% of the variance of self-assessed academic achievement ($F = 16.93, p < 0.001$). Information-searching ability ($\beta = 0.28, p < 0.001$) significantly

influenced self-assessed academic achievement. In the second step, the model in which self-directed learning and cyber-class flow were entered explained an additional 10.5% of the variance of self-assessed academic achievement ($\Delta \text{adj. } R^2 = 0.105, p < 0.001$). Self-directed learning ($\beta = 0.16, p = 0.026$) and cyber-class flow ($\beta = 0.27, p < 0.001$) significantly influenced self-assessed academic achievement. In the third step, the model in which satisfaction with online classes was entered explained an additional 1.8% of the variance of self-assessed academic achievement ($\Delta \text{adj. } R^2 = 0.018, p = 0.035$). Self-directed learning ($\beta = 0.18, p = 0.014$) and satisfaction with online class ($\beta = 0.19, p = 0.035$) were identified as significant predictors of self-assessed academic achievement. The overall explanatory power of the final model (Model 3) was 18.5% ($F = 12.33, p < 0.001$) (Table 5).

Discussion

This study aimed to investigate relationships between self-directed learning, cyber-class flow, obstacles to online learning, satisfaction with online classes, and academic achievement among undergraduate nursing students who took regular nursing courses online in the first semester of 2020 during the global pandemic caused by COVID-19 to explore ways to improve academic achievement and satisfaction with online classes. The mean score for self-directed learning was 3.03 out of 4 points. In a study that examined self-directed learning in undergraduate nursing students with a different instrument (Chung & Lee, 2016), the mean score was 3.56 out of 5 points. Findings of both studies showed that self-directed learning in undergraduate nursing students was above the medium level, although nursing college areas and class delivery methods might differ. Nurses provide optimal care to patients by

Table 4
Results of hierarchical regression analysis of factors affecting satisfaction with online learning (N = 200).*

Variable	Step 1					Step 2					Step 3				
	B	SE	β	t	p	B	SE	β	t	p	B	SE	β	t	p
(Constant)	3.53	0.07		47.81	<0.001	2.85	0.19		15.40	<0.001	1.75	0.31		5.58	<0.001
Types of universities (National · Public)*	-0.05	0.14	-0.05	-0.39	0.695	-0.02	0.13	-0.01	-0.12	0.904	0.01	0.10	0.01	0.06	0.956
Administrative districts of nursing schools (Seoul)*	0.15	0.15	0.10	1.04	0.299	0.12	0.14	0.08	0.80	0.424	0.16	0.11	0.11	1.49	0.139
Administrative districts of nursing schools (Others)*	0.31	0.15	0.29	2.05	0.042	0.27	0.15	0.25	1.83	0.069	0.17	0.11	0.16	1.51	0.132
Ability to use computers						-0.03	0.03	-0.10	-1.01	0.314	0.00	0.02	-0.01	-0.20	0.841
Ability to search for information via internet						0.11	0.03	0.34	3.60	<0.001	0.02	0.02	0.06	0.77	0.443
Self-directed learning											-0.10	0.08	-0.07	-1.17	0.245
Cyber-class flow											0.66	0.06	0.65	11.03	<0.001
Obstacles											-0.07	0.04	-0.10	-1.76	0.080
Adj R ²	0.034					0.105					0.489				
$\Delta \text{Adj } R^2$ (p)						0.080 (<0.001)					0.382 (<0.001)				
F (p)	3.30 (0.021)					5.69 (<0.001)					24.81 (<0.001)				

Durbin-Watson = 1.869 ($d_U = 1.841$); B = unstandardized estimates; SE = standardized error; β = standardized estimates; CI = confidence interval.

* Dummy coded= Types of universities (Private=0); Administrative districts of nursing schools (Metropolitan=0)

Table 5
Results of hierarchical regression analysis of factors affecting academic achievement (N = 200).

Variable	Step 1					Step 2					Step 3				
	B	SE	β	t	p	B	SE	β	t	p	B	SE	β	t	p
(Constant)	59.11	4.69		12.59	<0.001	26.33	8.38		3.14	0.002	18.65	9.06		2.06	0.041
Ability to search for information via internet	2.37	0.58	0.28	4.11	<0.001	1.13	0.60	0.13	1.88	0.062	1.02	0.60	0.12	1.71	0.089
Self-directed learning						6.20	2.76	0.16	2.25	0.026	6.79	2.75	0.18	2.47	0.014
Cyber-class flow						7.10	1.91	0.27	3.73	<0.001	3.62	2.50	0.14	1.45	0.150
Satisfaction											4.98	2.35	0.19	2.12	0.035
Adj R ²	0.074					0.171					0.185				
$\Delta \text{Adj } R^2$ (p)						0.105 (<0.001)					0.018 (0.035)				
F (p)	16.93 (<0.001)					14.68 (<0.001)					12.33 (<0.001)				

Durbin-Watson = 1.921 ($d_U = 1.809$); B = unstandardized estimates; SE = standardized error; β = standardized estimates; CI = confidence interval.

examining and integrating knowledge in diverse areas. Accordingly, the Korean Accreditation Board of Nursing Education (2017) requires nursing studies to be trained from undergraduate level to develop competence in integrating information and techniques to be applied in practice. In this context, the current study found that in self-directed learning, two items (“I know that not only my area of interest, but also other areas of knowledge are interconnected, and will be useful for me sometime in the future” and “When studying, I use the internet to search for a variety of information and knowledge”) showed the highest scores. It demonstrates that nursing students who will later become independent career nurses are aware of the need for ongoing self-directed learning. A previous study has reported that providing students in an online class with diverse methods and tools is beneficial in meeting their needs (Wingo, Peters, Ivankova, & Gurley, 2016), suggesting that it is essential to change the educational environment in online teaching by transitioning from the existing instructor-centered model to student-centered instruction to facilitate self-directed learning.

The mean score of the cyber-class flow was 3.37 out of 5 points (i.e., 67.31 in a 100-point scale). In comparison with the study by Shin, Kim, and Kim (2005) in which the mean score of cyber-class flow was 85.76 for the top 10% of cyber class students and 46.04 for the bottom 10%, the level of cyber-class flow in this study was between those scores. In this study, “telepresence” factor of cyber-class flow showed the highest mean score, suggesting that although participants were in an online class, they were engaged, perceiving telepresence at a high level as if they would be in an in-person class. This is consistent with the finding of a qualitative study on the learning flow in undergraduate nursing students (Park, 2017), showing that when focusing on an instructor’s lecture or learning process, participants experience a learning flow, such as losing track of time without feeling physiological needs. In contrast, in this study, “focused attention” had the lowest mean score among all factors of cyber-class flow. This suggests that students might have difficulty in focusing attention due to the free learning environment of an online class. This speculation is in line with a systematic literature review on the online component of blended learning (Rasheed, Kamsin, & Abdullah, 2020), which shows that online students face challenges such as self-regulation and time management. Accordingly, when preparing for online class in the future, instructors should develop strategies to attract students’ attention and proactively utilize such strategies during an online class.

Obstacles to online learning showed a mean score of 2.92 out of 5 points. The perceived level of obstacles to online learning was higher when grades of students, ability to use computers, and ability to search for information via internet were lower. Regarding factors of obstacles to online learning, “computing environment instability” showed the highest mean score. This factor included items such as “while taking online class, I was worried that my internet connection might be unstable”. Thus, the greatest obstacle seems to be anxiety related to an online class environment. Considering that Korea’s internet penetration rate including wireless and high-speed internet was 96% in January 2020 (Datareportal, 2020), which was at the top worldwide (Internet World Stats, 2020) and that internet speed connection in Korea also ranked the first globally, the current finding that the greatest obstacle was computing environment stability even in Korea, the most internet-connected country (Thompson et al., 2017), had remarkable significance. It suggests that for an online class, both facilities and a ubiquitous computing environment in which online learning is possible anytime and anywhere should be created. The current finding is in line with Lee’s (2013) study showing that the perception of obstacles is higher in the group with high anxiety over online class than in the group with low anxiety. Another study found that undergraduate nursing students who had a non-face-to-face class in the first semester of 2020 perceived frustration due to lack of communication with instructors as the most negative feature (Kim, 2020). Therefore, we speculate that the current study participants may have perceived more obstacles if there was insufficient feedback regarding the instability, when the online class

environment was unstable. When planning for online classes, instructors should make every effort to communicate fully with online students as a previous study (Wingo, Peters, Ivankova, & Gurley, 2016) has stated that instructors may feel isolated from their students with difficulty in confirming whether communication is effective during online classes. Thus, it is important to use a variety of means and tools such as phone calls and web conferences to actively communicate with students (Wingo, Peters, Ivankova, & Gurley, 2016).

The mean satisfaction score with online classes was 3.71 out of 5 points, similar to the result reported by Kwon, Han, Lee, and Bhang (2012) who developed the original scale. In their study, mean scores for factors of satisfaction with online class ranged from 3.5 to 3.8 out of 5 points in students taking general education courses. After reviewing studies that examined satisfaction with online and offline blended learning in nursing, mean satisfaction with a web-based health assessment course was 33.18 out of 45 points in one study on RN-BSN (Park, Lee, & Bae, 2010) and the mean satisfaction score of undergraduate nursing students who took online classes in the first semester of 2020 was 22.62 out of 40 points (Kim, Kim, Oh, & Jung, 2020). Thus, the level of satisfaction with online classes in this study was similar to or slightly higher than those of previous studies. Among factors of satisfaction with online classes in this study, the satisfaction with teaching method (“satisfaction with lecture contents and teaching methods”) and faculty activity (“satisfaction with faculty activity”) was higher than the overall or mean satisfaction. This finding was similar to a previous study finding based on 2583 middle and high school students who took online classes (Lee & Kim, 2018), showing that the quality of learning content and study support activity such as tutor’s feedback positively influenced students’ satisfaction with online classes. Likewise, in a study on 2192 undergraduate students in which online class teaching competency was examined (Nam, 2020), instructor delivery, instructor feedback, and classroom attitude ranked high, although there were some differences according to the major field of study. Accordingly, to enhance students’ satisfaction with online classes, it is essential for instructors to make an effort to ensure that the quality of online classes is at the same level as offline classes and to perform various proactive student-supporting activities such as providing feedback.

The mean score of self-assessed academic achievement was 78.03 out of 100 points. In a previous study (Park, Lee, & Bae, 2010) on a 4-week class to complete an e-book, self-assessed academic achievement showed a mean score of 31.29 out of 45 points and objective academic achievement had a mean score of 69.25 out of 100 points. Compared to results of the previous study, the level of self-assessed academic achievement in this study was slightly higher. However, it is difficult to directly compare between studies because the duration of online class in the study by Park, Lee, and Bae (2010) was different from that of the present study. On the other hand, the range of scores for self-assessed academic achievement in this study was wide, with a minimum of 20 and a maximum of 100, suggesting a need to explore specific ways to narrow the gap in achievement perceived by online students. In the future, researchers who plan to conduct studies on academic achievement of undergraduate nursing students taking online classes might need to comprehensively measure objective academic achievement in addition to self-assessed academic achievement.

Satisfaction with online class had significant correlations with self-directed learning, cyber-class flow, and obstacles to online learning, showing the highest correlation with cyber-class flow. It could be speculated that to successfully finish online classes, students’ willingness and effort are needed for self-directed learning in addition to the time required for watching lecture videos and attending online class in real-time. Additionally, it is believed that if students have accumulated experience of self-directed learning during online classes, their satisfaction with learning could increase. Results of this study confirmed that one relevant condition was none other than cyber-class flow. In this study, cyber-class flow showed a significant correlation with self-directed learning. That is, participants experienced cyber-class flow in

the process of self-directed learning, suggesting that diverse efforts should be made to develop self-directed learning ability to increase cyber-class flow. Among such efforts, instructors' praise and interest might be important factors for improving students' self-directed learning ability as a previous study has shown that students are more engaged in learning through instructor encouragement (Park, 2017). Self-assessed academic achievement was significantly correlated with self-directed learning, cyber-class flow, and satisfaction with online classes, but not with obstacles to online learning. The lack of significant correlation between perceived obstacles to online learning and self-assessed academic achievement might be interpreted in the same context as the finding of a previous study with undergraduate students taking online classes (Chei & Lee, 2017), in which perceived achievement was indirectly influenced by the physical–technological learning environment of learning via emotions. However, there was no direct impact of learning environment on perceived achievement. The current study finding that obstacles to online learning did not have a significant correlation with self-assessed academic achievement, despite the fact that participants were aware of several obstacles to online learning, might be due to a counterbalance between obstacles on one hand and the positive perception that online class was convenient and efficient on the other (Kim, 2020).

To identify factors influencing satisfaction with online classes, hierarchical regression analysis was conducted in three steps using general characteristics and other variables significantly correlated with satisfaction with online class as independent variables. It was found that cyber-class flow significantly influenced satisfaction with online classes. This finding was consistent with the finding of an empirical study (Shin, Kim, & Kim, 2005) showing that cyber-class flow had the greatest impact on satisfaction with online classes. It was also consistent with the finding of a meta-analysis on learning satisfaction of cyber university students (Joo, Kang, & Lim, 2016), showing that of endogenous variables, cyber-class flow showed the largest effect size on learning satisfaction. Among factors of cyber-class flow in this study, “telepresence” had the highest mean score. Items that belonged to this factor included “even after the class was over, I clearly remember the professor’s voice” and “I vividly remember how the screen was structured in the class.” The current study finding on telepresence was consistent with the finding of a meta-analysis on learning satisfaction in cyber university students (Joo, Kang, & Lim, 2016), showing that teaching presence had a large effect size on learning satisfaction. It was also consistent with the finding of a meta-analysis on social presence in an online environment (Richardson, Maeda, Lv, & Caskurlu, 2017), showing that social presence had a large effect size on satisfaction of online students. These findings demonstrate that a vivid experience of feeling like be in a real physical classroom is an important factor for improving satisfaction with online classes. Accordingly, when developing online class contents, instructors should try to increase student engagement. In contrast, the finding in a systematic literature review on online components of blended learning (Rasheed, Kamsin, & Abdullah, 2020) revealed that instructors expressed difficulties in acquiring new skills such as developing and editing online contents. This suggests that initially it might be necessary to increase instructors' technological competency to create high-quality online contents. In addition, a systematic literature review on online teaching and learning (Martin, Sun, & Westine, 2020) has only identified 21 (3.39%) articles on characteristics of instructors, signifying that data on the role and ability of instructors in online teaching are lacking. Thus, more research is required on these topics. A previous study (Howe, Chen, Heitner, & Morgan, 2018) has reported that satisfaction with online teaching is higher for faculty receiving institutional support such as mentoring for online teaching and training on the use of Learning Management System (LMS). This demonstrates that to develop and run online classes smoothly, efforts should be made not just by instructors, but also by educational institutions (including universities) that employ them. Hence, personnel support of various types will be needed in the future.

To identify factors influencing self-assessed academic achievement, hierarchical regression analysis was performed in three steps using general characteristics and other variables significantly correlated with academic achievement as independent variables. Self-directed learning and satisfaction with online classes were found to significantly influence self-assessed academic achievement. This finding shows that academic achievement is positively influenced if students with self-directed learning ability attend online classes, consistent with Park, Lee, and Bae (2010), reporting that self-directed learning readiness and satisfaction can explain 24% of the variance of objective academic achievement. This finding is also consistent with Chung and Lee's (2016), showing that students experience the feeling of being rewarded with increased confidence through self-directed learning. In a study conducted on Saudi Arabian students from a nursing and emergency medical service undergraduate program in a university (Alotaibi, 2016), desire to learn as one self-directed learning factor influenced academic achievement the most. This suggests that to increase academic achievement in undergraduate nursing students, they should first be positively motivated to learn from nursing lectures. Furthermore, based on the current study finding that satisfaction with online classes significantly influenced self-assessed academic achievement, satisfaction with online classes should be increased to improve academic achievement. In a study conducted with undergraduate nursing students in Taiwan (Lu, Lin, & Li, 2009), the experimental group that received a web-based course had higher scores for both knowledge and skill of intramuscular injection than the comparison group who attended conventional class only, demonstrating a positive effect of online learning on academic achievement. In that study, diverse methods were used to enhance students' understanding, such as providing prompt feedback on online students' questions and showing videos to help students understand abstract class content. It can be speculated that such efforts can improve satisfaction, thus contributing to an increase of academic achievement. Conversely, in a meta-analysis on learning satisfaction of cyber university students (Joo, Kang, & Lim, 2016), it was the instructor–student interaction that showed a large effect size on learning satisfaction. This finding demonstrates that even in an online class, decision making and providing feedback as immediately and promptly as in face-to-face classes are crucial factors for enhancing students' satisfaction. Accordingly, to improve academic achievement of undergraduate nursing students, it would be necessary to develop specific and practical ways to increase their satisfaction with online learning, such as by improving interactions with instructors. Additionally, it was found that teacher satisfaction was higher for faculty who taught 20 or more online nursing classes than faculty who taught five or less (Howe, Chen, Heitner, & Morgan, 2018). This suggests that online classes are a new teaching paradigm that the current generation of teachers living in the era of corona virus need to adjust to. Satisfaction can be increased not only for students, but also for their instructors. Satisfaction with online classes was identified as a significant predictor of academic achievement. Accordingly, cyber-class flow, a significant predictor of satisfaction with online classes, should be considered as an additional major variable to improve academic achievement.

This study identified factors influencing satisfaction with online classes and self-assessed academic achievement of undergraduate nursing students who took lectures via online learning in 2020, the COVID-19 pandemic era. Strengths of this study are as follows. First, findings of this study can represent Korea's situation as a result of collecting national-level data from Year 4 nursing college students. A third person, not online class instructors, was designated to inform students of the study and their rights considering ethical issues involved since students were a vulnerable group. An online survey instead of an in-person survey was used so that the data collection method would be appropriate for the current pandemic situation. In addition, all measurement instruments used in the study were tested for validity by performing exploratory factor analysis. Thus, the validity of this study was assessed to be high by utilizing scales of high reliability and validity and

appropriate for use in undergraduate nursing students.

Limitation

This study had a retrospective research design with limitation of recall bias. To reduce the recall bias, we tried to collect data immediately after finishing the semester. In spite of that, there was a gap of two months between lectures and data collection. Thus, there might be a recall bias.

Recommendations for nursing education

Based on findings of the current study, we have the following recommendations: 1) Strategies to enhance cyber-class flow of students should be developed and utilized in online classes; and 2) Nursing educators such as nursing professors and instructors need to challenge the use of various online learning tools and continuously try to increase their competencies about online classes.

Idea for future research

Further study is needed to compare effects between recorded video lectures and real-time lectures as a teaching-learning method of online learning on outcomes of nursing education programs.

Conclusions

In this study, major factors influencing academic achievement and satisfaction of undergraduate nursing students with online classes were identified. To improve academic achievement of undergraduate nursing students, self-directed learning and satisfaction with online class should be preceded. To enhance satisfaction with online classes, making efforts to improve cyber-class flow is a must.

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CRedit authorship contribution statement

Sunmi Kim: Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Seok Hee Jeong:** Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing, Project administration, Supervision. **Hee Sun Kim:** Conceptualization, Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Young Ju Jeong:** Investigation, Formal analysis, Data curation, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no conflict of interests.

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