

Improving Nursing Students' COVID-19 Knowledge Using a Serious Game

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Improving nursing students' understanding of the novel COVID-19 is an essential component of their education. We designed and developed a serious game-based computer learning application that requires nursing students to solve problems through simulated cases. This study aimed to compare knowledge mastery among nursing students who used this teaching method versus those who received online lectures. A retrospective observational study was conducted using preclass, postclass, and final test scores of 130 students retrieved from the university's database of test scores. Both teaching methods produced significant increases in short-term knowledge of COVID-19. There was no statistical difference between the two methods in pre- and postclass scores; however, the serious game group scored higher than the online lecture group in knowledge retention. In summary, the serious game application is a potentially effective method for COVID-19 education among nursing students, particularly in terms of its capacity for improved knowledge retention.

KEY WORDS: COVID-19 education, Education, Knowledge retention, Nursing students, Serious game

During the novel coronavirus disease 2019 (COVID-19) pandemic, universities worldwide temporarily migrated many courses to online formats.¹⁻⁴ Due to the lack of clear guidelines, nursing students, who would potentially be screening, diagnosing, and treating patients after graduation, were unsure of how to respond to patients with COVID-19.⁵ In addition, because of a lack of COVID-19 knowledge, there were concerns that nursing students might be unwilling to care for patients with COVID-19.⁵ Like qualified nurses, student nurses urgently needed to master

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the basic knowledge of the disease.⁶ Some universities held online lectures on COVID-19.⁷⁻⁹ However, there was limited literature on effective teaching methods for nursing students regarding COVID-19.

The serious game is an educational application designed to combine serious and fun aspects of games in a nonexhaustive and nonexclusive way for teaching, learning, or other purposes.¹⁰ Serious games have been considered a potentially effective method for promoting nursing education because they include simulations, are attractive and interactive, and offer immediate feedback.^{11,12} By providing an opportunity for students to apply their acquired knowledge and receive immediate feedback, serious games could help students learn readily within safe environments.¹³

We hypothesized that serious games were a potentially effective option for online COVID-19 education. The teaching team designed a serious game called the Covid-game to teach nursing students about COVID-19. Thus, this study aimed to compare the effectiveness of the Covid-game with that of the online lectures.

METHODS

Introduction of the COVID-19 Course

The teaching team collaborated with infectious diseases experts, established content and a syllabus, and designed a 3-hour online lecture on COVID-19. The content included the use of personal protective equipment, epidemiology, clinical manifestations, diagnoses, treatment, and the evaluation of patients with COVID-19. The courses were conducted in April and June of 2020. The students who volunteered for the course were divided into two classes based on the chronological order of their choosing the course.

The students in the April class were taught via online lectures (the lecture group). One week before the lesson, the students were provided with learning materials on COVID-19 and were required to preview the content before the lesson. The students were then required to participate in a 10-minute preclass test. After this, they attended a two-and-a-half-hour lecture on COVID-19. The teacher then devoted 10 minutes to questions and answers, followed by a 10-minute postclass test. Five weeks later, the students completed the final examination (Figure 1). Each test contained 10 multiple-choice questions (1 point per item) on COVID-19.

At the end of April 2020, the teaching team used Macromedia Flash 8.0 software to develop the Covid-game

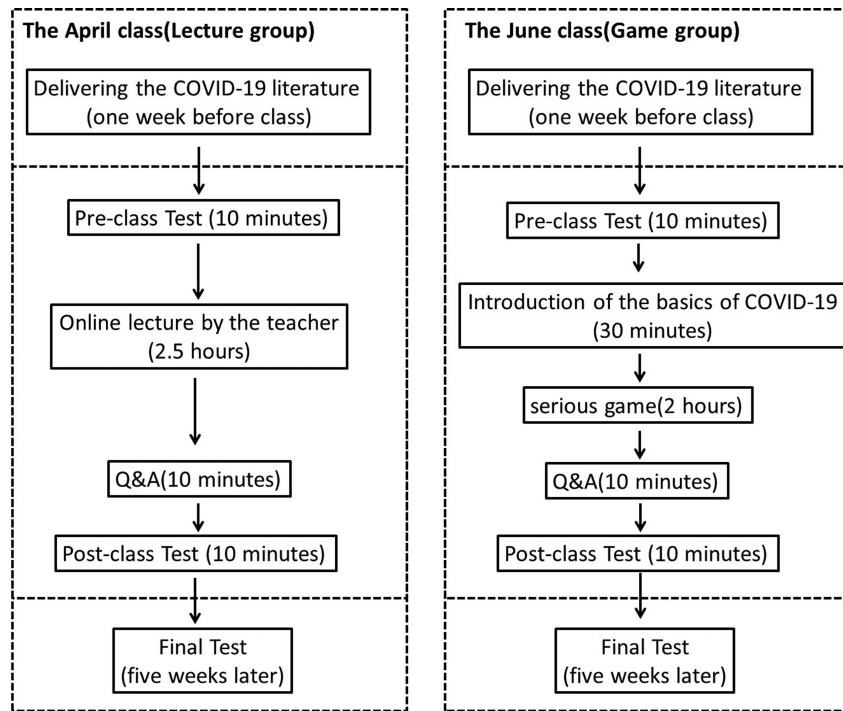


FIGURE 1. General overview of the study procedure. Q&A, questions and answers. The figure shows the teaching and testing processes for the two groups of students. The 3-hour online course was developed due to the novel COVID-19 pandemic.

to educate students about COVID-19. Therefore, the students in the June class acquired COVID-19 knowledge through the Covid-game (the game group). The reference delivery, preclass test, questions and answers, postclass test, and final examination in the game group were the same as those in the lecture group. The only difference was in the two-and-a-half-hour in-class teaching process: the instructor devoted 30 minutes to introduce the basics of COVID-19, followed by a 2-hour serious game.

Introduction of the Covid-Game

The Covid-game included three tasks (the game screenshots of the tasks have been provided in the Supplemental Digital Content, <http://links.lww.com/CIN/A136>). The total game time limit was 2 hours based on the curriculum design by the teaching team.

The first task was related to donning and doffing personal protective equipment, which required the player to organize all the personal protective equipment components in the correct order for a nurse who must put them on. Players had to start over if they made a mistake. The task had a time limit of 2 minutes, and exceeding this limit would cause defeat for the player, who then had to restart the current task.

The second task was to discern patients with COVID-19 from other patients with only fever. The Covid-game contained 13 cases, including three confirmed COVID-19 cases, five borderline COVID-19 cases, and five cases where

the patients had fever but not due to COVID-19. In this task, the players were randomly assigned five cases, from the 13 cases, by the Covid-game. For each case, the player chose a diagnosis from a popup window after acquiring information from the serious game. After completing all five cases, the player received the correct answers. There was no time limit for this task, but if the player completed the task faster, more time would be set aside for the next task.

The third task was the evaluation of confirmed patients with COVID-19 and the assignment of hospital beds. The player attended to multiple patients in a small hospital, which had five isolation beds, two ICU beds, and five ward beds (total 12 beds). Initially, the player received 20 patients along with their clinical information including age, sex, chief complaint, key points of present and past illnesses, key points of physical examinations, laboratory results, and x-ray results. The player had to evaluate all the patients and arrange hospital beds for them. If a character's death or nosocomial infection occurred because of the player's mistake, the task would restart. There was no time limit for this task, but the player needed to complete it within the total game time limit.

Study Design

This study was conducted at the medical and nursing school of a Chinese university, and the test scores of the 130 students were extracted from the university's database. The

Table 1. Characteristics of Both the Lecture Group and the Game Group

Item	The Lecture Group	The Game Group	P
	(n = 65)	(n = 60)	
Sex			
Male	11 (16.92%)	9 (15.00%)	.770
Female	54 (83.08%)	51 (85.00%)	
Age, y	23.98 ± 0.70	24.03 ± 0.74	.704
Test score			
Preclass test	4.20 ± 1.25	4.28 ± 1.17	.702
Postclass test	7.49 ± 2.35	7.67 ± 1.62	.633
Final test	6.67 ± 1.80	7.47 ± 1.35	.006*

*P < .05.

students' personal information, including their names and student numbers, was not extracted for ethical issues. There were 67 students (51.54%) in the April class (the lecture group) and 63 students (48.46%) in the June class (the game group). We compared the student groups with regard to sex, age, and preclass test scores. Afterward, we compared the postclass and final test scores. The local Institutional Review Committee approved the study and waived the need to obtain informed consent from the students owing to the study design.

Data Collection

All test scores of the selected students were collected from the test score database. Any missing test scores were regarded as incomplete data and excluded from the study. As two students in the lecture group and three students in the game group were absent from class, five students were excluded from the analysis. Therefore, there were 65 students (52.00%) in the lecture group and 60 students (48.00%) in the game group.

Statistical Analysis

All data were analyzed using IBM SPSS Statistics version 20 (IBM Inc., Armonk, NY, USA). The analysis of variance of repeated measurements with a subsequent Bonferroni correction was used to compare the preclass, postclass, and final examination scores. The trend line was plotted for each group of indicators at different time points. Differences were considered statistically significant at an alpha level of .05.

RESULTS

The number of male students in the lecture and game groups was 54 (83.08%) and 51 (85.00%), respectively. The average age of the lecture group and game group was 23.98 ± 0.70 years and 24.03 ± 0.74 years, respectively. There were no significant differences in sex or age (Table 1).

The result of the analysis of variance of repeated measures showed no statistical difference between the two groups in

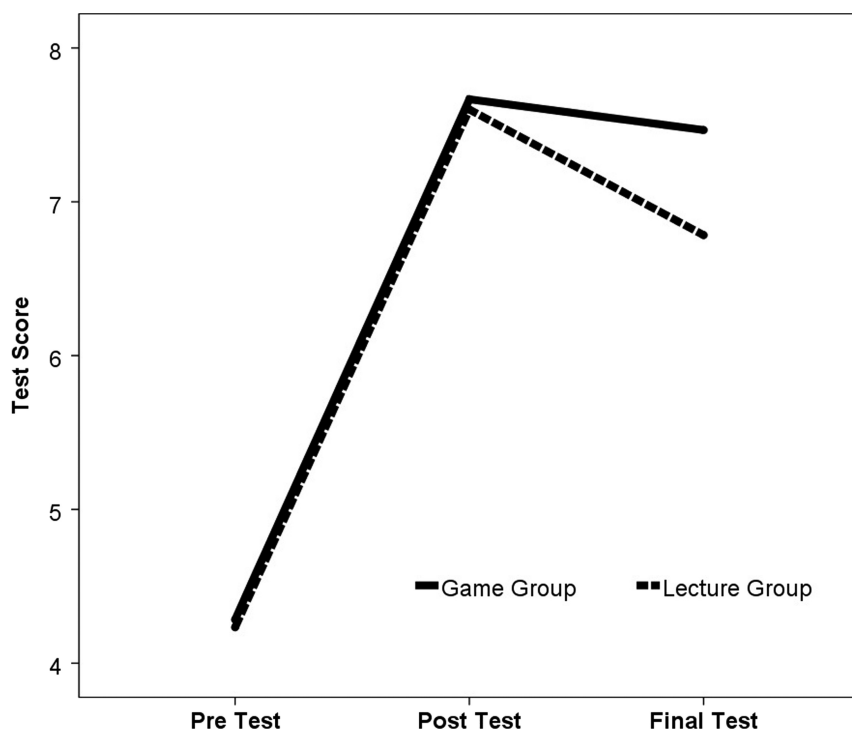


FIGURE 2. Score curves for all groups during preclass, postclass, and final test phases. The dotted line represents the mean score for the lecture group, and the solid line represents the mean score for the game group.

the preclass test and postclass test measurement time points. However, a significant difference was observed in the final test (Table 1), with higher knowledge retention in the game group (7.47 ± 1.35) than in the lecture group (6.67 ± 1.80) (Figure 2)

In the lecture group, a repeated-measures analysis of variance revealed a statistically significant difference between the preclass, postclass, and final test scores ($F = 131.64$, $P < .001$). All three pairwise comparisons (preclass and postclass; postclass and final; and preclass and final) using the Bonferroni test were also significant (Table 2).

In the game group, a repeated-measures analysis of variance revealed a statistically significant difference between the preclass, postclass, and final test scores ($F = 172.86$, $P < .001$). Except for the postclass test and final test pair, the other two pairwise comparisons (preclass and postclass, and preclass and final) using Bonferroni tests were significant (Table 2).

DISCUSSION

During the COVID-19 pandemic, mastery of COVID-19 knowledge is particularly important for nursing students, as they will inevitably contribute to caring for patients with COVID-19.¹⁴⁻¹⁶ However, their education was suddenly disrupted, and universities were mandated to switch to online teaching.¹⁷ Although some studies^{5,7,8} have explored the teaching content related to COVID-19, there is limited evidence on COVID-19 teaching methods, especially regarding online teaching.

In this study, we found that both online lectures and serious games were effective teaching methods for COVID-19 based on improvement in knowledge test scores. We also found that there was no significant difference between the online lecture and serious game student groups' test scores on the postclass test. This finding is consistent with the results of previous studies.¹⁸⁻²⁰ The study by Karbownik et al¹⁹ showed that serious games and lectures seem to improve short-term knowledge to a similar extent. A similar result

was also reported by Moradian et al,²⁰ who compared the effects of lecture and serious game methods in disaster risk education.

Our study also showed that, after 5 weeks, the knowledge retention of the game group was higher than that of the lecture group. The study by Chittaro and Buttussi²¹ of a serious game demonstrated that a more engaging and exciting experience—which is lacking in lectures but possible with games—contributed to the superior knowledge retention of game-based learning. Neuroscientists hypothesized that the reason for memory consolidation in serious games is that they cause emotional arousal, which leads to the increase in norepinephrine in the amygdala.²² This hypothesis was supported by the study of Tully and Bolshakov,²³ which revealed that emotional arousal leads to the activation of the locus coeruleus with the subsequent release of norepinephrine in the brain, resulting in the enhancement of memory. Furthermore, Ciprés-Flores et al's study²⁴ showed that a norepinephrine blocker significantly impaired memory of an emotionally arousing story, signifying that enhanced memory associated with emotional experiences involves the activation of the beta-adrenergic system. Thus, the Covid-game, which was designed with the possibilities of character death and task failure, is more likely to arouse players' emotions and thereby increase knowledge retention. Because the long-term effects of COVID-19 teaching are more important than the short-term effects and serious games are more likely to aid long-term knowledge retention, using the serious game was a potentially effective method in the online teaching of COVID-19.

Nevertheless, this study has various limitations. First, this retrospective observational study may be prone to sampling errors because the grouping of students was not random but based on the chronological order of the course selection. Furthermore, because we ran the groups consecutively rather than concurrently, there was a chance that the second group performed better because they had learned more about COVID-19 over time. Because the first group was

Table 2. Pairwise Comparisons to the Tests of Three Time Points

Pairs	Mean Difference	SE	P	95% CI
The lecture group				
Preclass test vs postclass test	-3.292	0.240	.000*	-3.882 to -2.702
Preclass test vs final test	-2.477	0.176	.000*	-2.909 to -2.045
Postclass test vs final test	0.815	0.214	.001*	0.290 to 1.341
The game group				
Preclass test vs postclass test	-3.383	0.228	.000*	-3.945 to -2.821
Preclass test vs final test	-3.183	0.189	.000*	-3.650 to -2.717
Postclass test vs final test	0.200	0.193	.910*	-0.275 to 0.675

* $\alpha' = .0167$ (Bonferroni correction) and $P < \alpha'$. There was significant difference between the pairs. 95% CI, 95% confidence interval.

trained sooner, they would not have had as much exposure to the media or ongoing knowledge development as the pandemic progressed. Therefore, randomized controlled trials are required. Second, the measurement of learning outcomes was limited to the knowledge test scores in this study because of a lack of specific method to measure the effects of COVID-19 education. Thus, there is a need to develop a specific method to measure the effects of COVID-19 education. Third, there was no evidence on which the total game time limit was determined; instead, the time limit was based on our curriculum design by the teaching team. In the future, we should explore a proper total game time limit. Lastly, the study was conducted by applying a specific game-based computer application about COVID-19 knowledge, which means that prudence is warranted when extrapolating our results to other game-based computer applications.

CONCLUSION

The game-based computer application that we designed was found to be potentially effective in teaching nursing students about COVID-19. Compared with online lectures, this learning mode enabled nursing students to master and retain knowledge for a longer period.

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