ORIGINAL RESEARCH

An action research on the application of online teaching in "Infection Control in Nursing Practice" course

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ABSTRACT

This study adopts the action research method to understand the impact of online teaching on the learning outcomes of working nursing students using the "Infection Control in Nursing Practice" course as the research context. The research design focuses on the learning activity process of online teaching. The study subjects consisted of 55 working nursing students, aged 25-55 years old, all of whom were taking the online courses for the first time. The results of the study show that the semester grades of online teaching courses were better than those of physical courses and the length of important learning activities such as audio-visual materials (AVMs) would best be produced within 5-12 minutes, while the key points of each section would best be explained within 5 minutes of the beginning of the AVMs. Working students may miss out a variety of online learning activities, so a reminder mechanism should be planned to prevent students from missing out learning activities. The teachers are facilitators and advisors in online teaching, so they may plan time outside of learning activities, such as office hours, to provide a channel for student consultation. The results of this study can be used as a direction to improve the subsequent online teachings and provide a reference for other teachers to implement online teaching.

Key Words: Online teaching, Infection control in nursing practice, Action research

1. INTRODUCTION

Action research is research conducted by schoolteachers on their practice work processes to address problems faced in their workplaces.[1] Due to the inherent gap between values, beliefs, and practice, the academic field has begun to adopt action research methods. A study showed that multiple teachers recorded and reflected on the actions, events, thoughts, dilemmas, and feelings participated in and that such a cycle of reflection and action helped to bridge the gap between academia and practice.[2] Meanwhile, action research is well suited to the development of theories. In addition to providing important information, it also links to specific contextually relevant academic knowledge.[3] An action research on mathematics teachers, with research data from weekly planning and reflection meetings, activity worksheets, reflection journals, and lesson recordings, focused on conceptualizing teachers' experiences and providing opportunities to discuss important issues in order to improve their skills in curriculum planning and implementation.[4] Action research can take good ideas from theorists and translate them into rigorous, well-founded, relevant and usable methods.[5] There are also some nursing practices or teaching that are being conducted via action research, such as a shift to a patient-centered care in intensive care unit through action research.[6] Meanwhile,

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a nursing school in Indonesia implemented a participatory action research approach to develop and evaluate a model for preparing nurses for licensure examinations, and the participating teachers and graduates were satisfied with the results. It was also effective in improving the professional standards of nursing graduates.[7] In addition, the adoption of participatory action research can enhance nursing students' reflections on medical and surgical nursing and make them aware of the learning challenges and the need to change their learning attitudes and approaches.[8] In clinical practice, hospitals can conduct action research to evaluate multicultural nursing care programs and suggest effective strategies to help revisit training programs for new nursing staff and further enrich the experience of new nurses.[9] A study on improving hand hygiene in intensive care units showed that action research interventions to promote hand hygiene in intensive care units are effective.[10] Action research is dynamic, driven by a spiral process to identify problems, design solutions, and evaluate solutions. It is considered applicable to improving the efficiency of practical pharmacy operations in addition to its application in the nursing domain.[11]

The COVID-19 epidemic has disrupted the current state of education worldwide and in Taiwan, where the educational scene is now almost entirely dominated by online learning. For online teaching, the pictures, texts, videos, and so on are uploaded to an online platform for storage through the Internet so that users can obtain relevant information for learning and communication even though they are in different places, especially for education, which has been implemented internationally for years.[12] It is now gradually accepted by the public in Taiwan, but its application may be affected by the hardware, users and course attributes.[13] Online teaching is one of the methods of distance education, as well as a form of digital learning.[14] A university in Taiwan implemented online teaching and found that students were mostly supportive of online teaching, and most teachers believed that they could master online teaching but consider that physical teaching would remain the main method in the future.[15] In any case, with the current global epidemic, teaching through the Internet will be necessary. The application of online teaching in Taiwan initially started in universities and colleges, and later expanded to high schools and elementary schools for purposes such as character education.[16] Online teaching is different from the traditional face-to-face teaching format, how to ensure its quality is very important. Schools should establish a well-functioning learning platform to ensure learning outcomes of students, including evidence of all learning outcomes such as classroom assignments, study time, and so on.[17] Some studies have also found that the more online experience students have, the more satisfied they are with their learning, the more effective the learning will be, and the more willing they are to take online teaching courses.[18] There are two types of instructional approaches to online learning: resource-based learning, in which students develop the ability to identify problems, solve them, and learn on their own through planned instructional activities, and demand-based learning, in which students determine the time, place, and pace of learning.[19] Since this course is designed for working nursing students, they are all over 20 years of age. According to a study in Taiwan, adult learners are receptive to the online learning model and use the interaction and sharing of virtual communities to achieve knowledge enhancement and learning cohesion.[20] In order to make teacher-student interaction more frequent through the characteristic of the Internet, the applications of distance education applications include video conferencing software and social media platforms, and applying these technologies requires an understanding of the functions and limitations of these platforms.[21] Meanwhile, teachers should provide the support and information necessary for students' learning when engaging in online teaching. Teachers should not only know how to use learning management systems or video conferencing tools, but should also introduce reflective learning activities.[22] Another study showed that both students and teachers agreed that learning activities in online courses must take a certain time, and that students found online courses more conducive to learning than physical classes, especially for discussion of topics.[23] During the epidemic, online teaching was conducted in some elementary schools and high schools in India, and significant differences in learning outcomes were found between students with different goals and perceptions of learning. The learning outcomes also relate to school types, locations, and genders of students.[24] Online teaching is an alternative channel for students who are unable to attend schools and can be used in general clinical practice health education. For example, in an online teaching program applied to pediatric dental trauma education, the students' learning performance was excellent.[25]

Working nursing students were not able to attend school because they had to manage their own health as they were caring for confirmed COVID19 cases, and it affected their learning outcomes. Action research is a research method that is based on the need for solving practical problems and can effectively solve problems through systematic research.[26] This study used the online course on "Infection control in nursing practice" as the research context to develop a multivariate assessment method, so as to recognize and discover students' potential and to document and reflect on the planning of the online teaching courses and students' online learning experiences through an action research approach.

2. METHODS

This study adopted the action research approach, using the "Infection Control in Nursing Practice" course as the research context and the students taking the course as the study subject, and the study design focused on the learning process of online teaching activities.

2.1 Research participants

The study was conducted with a class of 55 working nursing students, aged 25-55 years old, who were all licensed as certified professional nurses. They are either practitioner nurses, clinical examination nurses, or nursing staff working in schools, and none of them is an infection control nurse.

2.2 Research tools

The online teaching learning effectiveness questionnaire was used to assess students' learning effectiveness, and the online learning history of each student was used as the assessment tool, including AVMs browsing history, online homework assignments, online discussions, and online tests.

2.3 Research process

The online teaching platform of the School has many functions such as synchronous and asynchronous distance education, online testing, online assignment submission, group discussion and learning analysis. The process of this study was divided into three phases: pre-course, during the course, and post-course, as described in Table 1.

Table 1. Online teaching phase

Teaching Practice Phase	Item	Teaching Content
Pre-course	Preparation of teaching materials	Set the objectives, contents, teaching activities of the section and pre-record AVMs in accordance with the school's online teaching standards, and have them approved by the external auditors appointed by the school.
	Teaching Activities	Plan the case analysis based on the key concepts of the section, discuss the suitability of the test questions, and simulate the clinical situations.
During the course	Synchronized Distance Education	Explain the operation method of the online teaching platform, the browsing of AVMs and various teaching activities, and guide students to use the query function to learn how to search for information.
	Asynchronous Distance Education	Learn the content of the section online and carry out various teaching activities such as topic discussions, tests, and assignment submissions. Provide feedback thereafter.
Post-course	Reflective Review	Learning analysis, fill out the Learning Effectiveness Self-Assessment Questionnaire and analyze.

2.4 Data analysis

This study adopts mixed-model methodology to collect qualitative and quantitative data in teaching and learning for comprehensive analysis and discussion. The sources of data for the study included online questionnaires, online AVMs browsing history, online assignments, online discussions, online tests, online messages announced by teachers and students, the researcher's self-reflection and so on. The learning effectiveness questionnaire was designed using the 5-point Likert Scale with the percentages and averages calculated using Microsoft Excel.

3. RESULTS

This course had been conducted in the physical form in the past, but this time it was conducted by online teaching. This was the first time these working nurses taking online teaching courses. The course would last for a total of 18 weeks, of which the 1st and 9th weeks were conducted in physical form, and the 18th week was changed from physical form to online synchronous teaching due to the epidemic. There were 27 AVMs and 32 reference materials for this course, and the results of the study are illustrated by semester grades, course completion rate, online learning activities, and questionnaires.

3.1 Semester grades

The working nursing students taking online courses in this study had a higher average semester grade compared to that of the last face-to-face course. One of the students scored less than 60 in the physical course, while all the students scored above 60 in the online teaching course. The grades of students are shown in Table 2.

3.2 Completion rate of course

Completion rate of course, which includes completion of weekly learning activities, averaged 94.1%, with the highest and lowest completion rates at 100% and 66.7%, respectively. After further analysis, the two students with the lowest course completion rates were at 66.8% and 66.7%, and

their semester grades were 88.2 and 77.4 respectively. One of them had a grade above the 84.4 average for all students and the other had a grade below the average, indicating that course completion rate is partially correlated with semester grades.

Table 2. Comparison of grades between physical course and online teaching course

Grades from physical course		Grades from online teaching course	
Semester Grade Range	**Number of students**	**Semester Grade Range**	**Number of students**
90-99	3	90-99	23
80-89	34	80-89	29
70-79	19	70-79	1
60-69	3	60-69	2
50-59	1	50-59	0
Average	80	Average	84

3.3 Online learning activities

3.3.1 *Browsing of AVMs*

AVMs are an important part of online teaching. The total number of visits by students to the AVMs was 3,076. The following is an analysis of the number of hours visited by individual students, the statistics of viewing completion rate, and the learning of the AVMs for the section.

1) Statistics on individual student viewing hours: Students with the top three viewing hours viewed for 43h55m42s, 41h55m35s, and 39h16m50s, respectively. Students with the three lowest viewing hours viewed for 01h15m37s, 05h01m39s, and 05h03m26s, respectively. Further analysis shows that students with the top three viewing hours of AVMs had semester scores of 89, 88, and 88, respectively, all higher than the class average of 84.4. Students with the shortest viewing hours had semester scores of 82, 87, and 84, respectively, with two of the students' semester scores being lower than the class average.

2) Statistics on the completion rate of AVMs: There are 27 AVMs in this course, and 13 of which were completely viewed by 55 students, 7 were completely viewed by 54 students, 4 were completely viewed by 53 students, 2 were completely viewed by 52 students, and 1 was completely viewed by 48 students. The AVM with the lowest completion rate is "Wound Care and Infection Control", which is an issue that should be explored in depth when planning future courses.

3) Analysis of the planning and learning of AVMs: Among the 27 AVMs in this course, the one with the lowest viewing completion rate was "Wound Care and Infection Control", which is 47 minutes and 24 seconds long, and the average number of viewings was 1.20. It drops to 1.13 at 13 minutes into the material and 1.11 at the 15-minute mark, indicating that some students watched the front or back portion of the materials and skipped the middle portion of it. The viewing results thereof showed that 41 students completed 100%, 6 students completed below 50%, and 2 students completed 0%. In addition, 6 out of 27 AVMs were less than 10 minutes long, 8 were between 11 and 20 minutes, 3 were between 21 and 30 minutes, and 9 were 31 minutes or more. The longest one was 50:32 long and the shortest one was 3:27. The shortest AVM was "Daily Assessment of Urethral Catheter" with an average viewing number of 1.58, while the longest AVM was "Prevention of Infections Associated with Invasive Medical Devices" with an average viewing number of 1.09, which was lower than the average viewing number of "Urethral Catheter Daily Assessment".

3.3.2 *Online test statistics*

Three online tests were planned for this course, and the rates of taking the online tests were 83.64%, 89.09% and 100%, respectively. Since the subjects were working students, a reminder mechanism was planned and the taking rates of the online tests of students were getting higher and higher. Since each online tests account for 5% of the grade of each semester, students who did not take the online tests also would have lower semester grade. In the future, the percentage of students taking the online tests proactively needs to be improved.

3.3.3 *Online topic discussion*

There were 6 topic discussions such as "what do you think are the reasons that clinical infection control has not been done well?" and "as a nursing staff, what should you do to improve quarantine measures?" The participation rate for the six discussions ranged from 92.73% to 100%, with an average of 95.76%. According to the statistics of the number of visits by students to participate in the topic discussions, students with the top 3 numbers of discussion participation had 727, 586, and 501 visits, respectively, and the semester grades

of those students were 95, 92, and 88, respectively. On the contrary, the students with the lowest number of discussion participation had 61, 53, and 52 visits, and their grades were 86, 60 and 92, indicating that students with more visits and participation in topic discussions had better semester grades. For online teaching, it is hoped that students can have critical thinking about infection control issues in nursing practice, give their opinions, and learn from each other.

3.3.4 *Online assignment*

Online assignment submissions are learning activities of online teaching, and two assignments were to be submitted with each accounting for 5% of the learning assessment score. The submission rate of the first assignment was 100%, and 6 of the students did not submit their second assignments. Those 6 students had semester grades ranging from 66 to 89, with only one student scoring higher than the class average of 84.4, indicating that various learning activities should be encouraged or required to be completed by students, and a reminder mechanism should be in place.

3.3.5 *Self-assessment results of course learning effectiveness*

This study used the "Infection Control in Nursing Practice" as the study context and 46 valid responses of Learning Effectiveness Self-Assessment Questionnaires were collected.

Statistical results indicate that at least 95% of the students, in their self-assessments, considered themselves achieved the learning objective #1 of the course, "Able to understand the definition, sources, and impact factors of nosocomial infections." The learning objectives #2, #3, and #5 are "Able to understand the role and functions of nursing staff in nosocomial infection control", "Able to understand and inquire the principles of quarantine and the skills to properly perform quarantine", and "Able to understand the implementation of bundle care and proactively inquire about related information", respectively. The average achievement rate was 93%, while the learning object #4 "Able to understand the notification system and prevention of emerging and various infectious diseases" had the lowest average achievement rate of 90% among the five objectives. In the future, the notification and prevention of emerging and various infectious diseases can be further strengthened. More than 90% (4.83) of the students agreed that the teaching content would enhance their knowledge of infection control, and more than 90% (4.78) of the students agreed that they could apply what they learned through online learning to clinical care. In addition, more than 90% (4.59) of the students agreed that online learning is a way to schedule their own study time and enhance the effectiveness of their learning. The students' comments include, "It helped a lot in nursing practice and helped me learn how to deal with infected patients." "It allowed me to learn more and I can re-visit the courses at home afterwards. It can link to the current epidemic." "I work in the pediatric ward. The course gave me a better understanding of how to avoid cross-infection when caring for patients, and I can also educate the families of the patients of that." "I have benefited a lot from the latest knowledge of COV-19 in the statutory infectious disease section." "Because I work in emergency room, I sometimes come into contact with lots of patients and need to be highly alert to infectious diseases" and so on, indicating that the online course was useful for their nursing practice. In addition, students also made suggestions for online learning, such as "I think it is fun to see the views of many students through discussion, and while some of them may be afraid to speak up, when they did speak they gave very interesting opinions." "I think topic discussion can be divided into smaller groups as there are many students in one class, and most of their opinions were somewhat similar or they were discussing different topics." "I hope to have a few classes in which I could share with teachers and other students about infection control in various hospitals," and so on.

4. DISCUSSION

The researcher reflects on the implementation process of online teaching and presents the following discussion and description.

4.1 The effectiveness of online teaching versus face-to-face teaching

The fact of students having higher grades in online teaching courses than in physical courses shows that there is a difference between the effectiveness of online learning and face-to-face learning. Participating students had never taken any online teaching course before. Most of the students were able to learn on their own and provide opinions during discussion, while a few students had to be reminded to complete the course. Therefore, during the implementation of the online course, it was necessary to pay attention to the completion rate of students in various learning activities in order to achieve the learning effect. A study conducted during the epidemic showed that online learning outcomes for community college working nursing and health students were strongly correlated with ages of students, faculty support, and effective communication styles.[27] Therefore, in addition to the prior planning of online teaching courses, teachers must be involved during its implementation process to understand the completion of learning activities, especially when the students are working students who may miss some learning activities due to their work.

4.2 AVMs for online teaching

According to the analysis of AVMs viewed throughout the semester, the average viewing number by students on AVMs of 3-10 minutes was more than that of AVMs of 30 minutes or longer. Furthermore, per the analysis on the AVM "Wound Care and Infection Control" that had the lowest viewing completion rate by students, students mainly focused on the first 12 minutes of the material, with the first 5 minutes having the highest viewing count. This also shows that to improve the effectiveness of students' viewing of AVMs, the length of the materials should first be adjusted. The length of the AVMs may best be between 5 and 12 minutes. In the future, attention should be paid to the length of AVM when recording them to make them 12 minutes or less, and the key points of the section should be explained within first 5 minutes of the AVMs in order to enhance the viewing rate and learning effectiveness thereof. A study on AVMs for patient health education showed that short versions of AVMs are easier to understand and more suitable for learning.[28]

4.3 Arrangement of learning activities for online teaching

The planning and arrangement of learning activities for online teaching courses is very relevant to learning outcomes. In addition to viewing AVMs, there are online assignments to be submitted, participating in online discussions and taking online tests. Moreover, further to explaining the course content in the first week of the course, a reminder mechanism was provided regularly for students who may miss learning activities so as not to affect the effectiveness of learning. In addition, for the discussion topics for working students, sharing experiences related to clinical care can also be arranged so that students working in different medical institutions can learn experiences from each other. Teachers play a very important role in online teaching. They are responsible for guiding students through their learning and providing directions for problem solving. Therefore, teachers of this online teaching course also made themselves available during office hours after the midterm examination to take questions from students and answer them. During the recent epidemic, many physical courses have been switched to online teaching, including synchronous and asynchronous distance education. However, it is recommended that different online learning progress and learning activities should be designed according to the characteristics of different age groups.[29]

5. Conclusions

The results of this study showed that working nursing students had better learning outcomes in online teaching courses than in physical courses, and their self-assessments of learning outcomes were mostly positive. It was found in the reflection on the implementation of online teaching that the planning of learning activities for online teaching is very important, as well as the familiarity of teachers and students with the online teaching platform. In addition to the planning of teaching activities for the overall course in accordance with the school's online teaching guidelines, extra time should be allocated for interaction with students to provide consultation on students' issues, and teaching assistants for digital learning can be arranged to assist students in the operation of online learning. In the future, it is suggested that the course content should be more oriented towards practical case studies and group sharing of practical experiences, so that students can learn different experiences of others.

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Conflicts of Interest Disclosure

The authors declare that there is no conflict of interest.

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