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The effect of case-based e-learning on academic performance and problem-solving ability in nursing students: A pre- and post-test study

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Abstract:

BACKGROUND: Case-based learning is a modern learning approach, aims to prepare students for practical skills. In the present study, we aimed to determine the effectiveness of case-based e-learning (CBEL) on the academic performance and problem-solving ability of nursing students.

MATERIALS AND METHODS: In this pre- and post-test study, census sampling method was used to select 128 nursing students who had nutrition courses during 2015–2017 at (blinded). Before and after the educational intervention, the students completed the problem-solving inventory including problem-solving confidence (PSC), approach-avoidance style (AA), and personal control (PC) and a scientific test for evaluating academic function. Continuous variables before and after the intervention and categorical variables were analyzed using paired *t*-test and Chi-square test, respectively.

RESULTS: The mean scores of PSC, AA, and PC decreased after the intervention ($P < 0.001$). The mean scientific score of the students improved after the intervention ($P < 0.001$).

CONCLUSION: This study showed that the CBEL method had a positive effect on the ability to solve the learning problems and the academic performance of the students and can be used to train nurses to improve their ability to confront clinical problems in the future.

Keywords:

Academic performance, distance, education, problem solving, problem-based learning

Introduction

Nurses deal with different patients with a variety of medical problems and thus, need to make appropriate clinical decisions for expert and efficient nursing. The clinical performance of the nurse is therefore not only based on their theoretical knowledge but also proficiency of cognitive skills, such as problem-solving skill, an intellectual process that involves critical thinking for using the person's knowledge to find a solution to a clinical problem.[1] It seems that there is a gap between theory and practice at many centers, where the traditional theoretical education is the mainstay of the educational package.[2] With the advent of new technologies, modern educational methods have been suggested for the integration of theory and practice.[3,4]

E-learning which refers to the process of students' access to the educational content from any place, has been increasingly used as a modern way of access to the educational content. In addition to the advantages, e-learning has several challenges, including the inability of the instructor to evaluate their students' comprehension, the inability of students to ask their questions and share ideas, and the quality of the provided educational content.[5] Accordingly, there is a need

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for designing well-established e-learning teaching methods, especially in nursing.[6]

Case-based learning (CBL) is a modern learning approach utilized in the healthcare teaching system, aims to prepare students for practical skills by encountering a real patient case, similar to that in the real world,[7] which has been confirmed to be more effective than the traditional method in 1st-year oncology postgraduates[8] and pathology students; the efficacy of which has also been confirmed in nursing students.[9,10] Because of the ease of access of e-learning, the case-based e-learning (CBEL) method has been suggested as an effective educational method for medical students[11,12] and veterinary students.[13] Although the combination of e-learning with traditional methods has been suggested as a superior learning style in nursing students,[14,15] few studies have evaluated the effectiveness of CBEL method in nursing students,[16] especially on the problem-solving skills of nursing students. Therefore, in the present study, we aimed to determine the effectiveness of CBEL on academic performance and problem-solving ability of nursing students in a nutrition course.

Materials and Methods

Study design and setting

In this pre- and post-test study, nursing (master) students were participated during the academic years of 2015–2017 at (blinded). The nutrition course of the students was selected for the CBEL, which included two main topics of "The principles of nutrition" and "Nutrition therapy." Three nutritionists designed the course details, which included eight cases finally; each case included a clinical scenario and some questions. The scenarios were prepared by a performance-based development system, which included problem identification, essential clinical information reports, applying independent interventions, distinguishing emergencies and priorities, the anticipation of relevant medical instructions, and providing reasonable and secure supportive decisions. The scenarios and questions were reviewed by four professors of nutrition and medical education specialties. The e-learning content was designed for 9 months under the supervision of medical education specialists at Center of Excellence for E-learning, (blinded), based on standards,[17] using Flash software. Furthermore, the prepared e-content was provided to ten students who have passed this course, and their recommendations were added to the content. Each session included the following sections: Goals and objectives of the training, providing the clinical scenario, practice, and feedback using quizzes. The student could pass to the next level only after providing the correct response, designed for better learning and feedback to the students. The summary and conclusions, as well as references, were provided at the end of each session via videos, photos, and other files. The designed educational e-content was provided on DVDs to the students after each group of 5–6 students was taught by three nutritionists about how to work with the software during a 45-min session. The nutritionists (who had at least 3 years of being faculty members of the university in the Nutrition Department) were completely educated about the objectives of this educational method. The students were able to share ideas and discuss the case after the end of the session; also, the researcher was responsible for answering the questions and problems of the students while using the software.

Study participants and sampling

Nursing (master) students who had nutrition course were considered the study population and asked to participate in the study, if they were familiar with computers, by two calls during the 2 years of the study and a total of 128 students volunteered. We included all volunteer students in this study by census sampling method but, considering large effect size (0.5) and taking into account a type one error of 0.05, at the base of the main outcome variable, for statistical power, we performed *post hoc* power analysis using G*power (ver. 3.1.9.2, Erdfelder, Faul and Buchuner, Germany) which results showed power was equal to 97%.[18]

Data collection tool and technique

Before and after the intervention, the students were asked to complete the problem-solving inventory (PSI), developed and validated by Heppner and Petersen in 1982 for self-evaluation of an individual from his or her problem-solving ability.[18] This 35-item instrument includes three factors of effectively solving problems: Problem-solving confidence (PSC), approach-avoidance style (AA), and personal control (PC). Each item is scored from 1 to 6 on a six-point Likert scale; 20 items are scored by strongly agree (scored 1) to strongly disagree (score 6), and 15 items scored reversely (strongly agree is scored as 6 and strongly disagree is scored as 1). The total score ranges from 32 to 192, and lower scores show better functional problem-solving ability. The Persian version of PSI was used in the present study, which has been previously shown to have high reliability by a Cronbach's alpha coefficient of 0.94 in nursing students.[19] The participants' academic performance was tested by a scientific test before and after the intervention. The scientific test was designed in the desired content, and all the questions of this test were designed by the nutritionists (who took part in the study) based on the learning goals of the educational package, the content validity of which was reviewed and approved by three professors and nutritionists. The total score of the test was calculated as 100. The demographic characteristics of the students were also recorded, which included age,

sex, marital status, a native of that city or coming from other cities, place of living (dormitory or personal house), and the mean score of the previous academic year. In addition, the student's experience of using educational software and computer knowledge was assessed.

Ethical consideration

The design and objectives of the study were explained to the volunteers, and they were asked to read and sign the written informed consent. The protocol of the study was approved by the Ethics Committee of (blinded) (code: 10376).

Statistical analysis

The collected data were input into the statistical software IBM SPSS Statistics for Windows version 21.0 (IBM Corp. 2012. Armonk, NY, USA: IBM Corp), used for the statistical analyses. Variables were described using mean ± standard deviation or number (percentage). The difference in the mean values of continuous variables before and after the intervention was determined using paired *t*-test and categorical variables using Chi-square test. For all tests, $P < 0.05$ was considered statistically significant.

Results

Results of Chi-square test revealed that out of 128 students, 97 were women (75.8%), and the most (91.4%; $n = 117$) were single. There were no significant differences between categorize of all variables ($P > 0.05$ for all variables). The complete demographic characteristics of the students are shown in Table 1.

The mean scores of the students in the three dimensions of PSI, as shown in Table 2, indicate lower scores in all three dimensions, including PSC, AA, and PC, after the intervention, compared with before the intervention [$P < 0.001$; Table 1]. In addition, the results of the scientific test show a significant improvement in the students' mean scores [$P < 0.001$; Table 2].

Table 1: The demographic characteristics of the students

Variable	Categories	Frequency (%)
Sex	Female	97 (75.8)
	Male	31 (24.2)
Marital status	Single	117 (91.4)
	Married	11 (8.6)
	Divorced	0
City of origin	Born in Kerman	26 (20.3)
	Born in other cities	102 (79.7)
Living place	Living in dormitories	51 (39.8)
	Living in a personal house	77 (60.2)
Mean score of the student	>17	18 (14.1)
	12-17	106 (82.8)
	<12	4 (3.1)
Computer use per week	<5 h a week	5 (3.9)
	5-10 h a week	86 (67.2)
	>10 h a week	37 (28.9)
Computer knowledge	Basic	34 (26.6)
	Intermediate	85 (66.4)
	Advanced	9 (7)
Past experience of using an educational software	Yes	30 (24.3)
	No	98 (76.6)

Data are, *n* (%)

Discussion

In the present study, we showed that the carefully and professionally designed CBEL educational method could significantly improve the nurses' problem-solving skills and scientific knowledge. These results confirm that of previous studies, which referred to the importance of training problem-solving skills to the nursing students in the improvement of their critical thinking and decision-making abilities,[20,21] as well as studies confirming the effectiveness of e-learning in nursing education.[14,15] Nevertheless, none has investigated the effectiveness of CBEL problem-solving skills of nursing students to be comparable to our results, as far as the authors are concerned.

Problem-solving ability is an important determinant of nurses' performance[22] and considered protective against perceived stress among nurses,[23] which has thus been considered as the main outcome in the present study. Our results showed significant improvement in all of the three domains of PSI, which is in line with the results of previous studies that refer to the importance of training problem-solving skills to nursing students.[24,25] Using PSI, Kocoglu *et al*. showed that an interactive problem-solving training program to first-line nurse managers resulted in the change in PSC score after intervention and in AA score, while the improvement of PC was only observed 6 months after intervention.[26] Although the results of this study confirm the effectiveness of training on the problem-solving ability of nurses, in line with the results of the present study, the implemented educational program and method and the target population differed; more studies are thus required in this regard.

Jeong and Park showed that CBEL could improve the nurses' attitude and practice towards evidence-based practice, as well as clinical questioning confidence and knowledge, compared with the written material provided to the control group.[16] These results are in line with that of the present study, considering the effectiveness of CBEL. In the study by Chan and others, the traditional method of CBL was provided to the nursing students in the first semester and the web-based method in the next semester to the same students, and the results showed no difference in the self-learning ability,

Table 2: Comparing the Students' mean scores in the three dimensions of problem-solving inventory and scientific test before and after the intervention

	Before the intervention	After the intervention	*P**
Problem-solving confidence	39.64±3.60	33.39±2.68	<0.001
Approach-avoidance style	58.98±3.94	47.47±4.32	<0.001
Personal control	18.57±2.11	14.16±1.86	<0.001
Scientific test	47.89±11.30	81.32±7.72	<0.001

*The results of paired *t*-test

clinical reasoning ability, and satisfaction between the two methods. This study confirmed that CBEL is at least as effective as CBL in nursing students,[27] which implies that we can compare the results of our studies with those performing CBL, although a definite conclusion requires more studies.

A review of studies has confirmed the effectiveness of CBL in the healthcare system; however, these results may not completely match ours, as the most common presentation method reviewed was live and the most were medical students.[7,28] Yoo and Park evaluated 190 newly graduated nurses, and a comparison of the effect of CBL versus lecture-based education demonstrated higher objective and subjective problem-solving ability in the CBL method.[9] These results are in line with that obtained in the present study, considering the efficacy of CBL on the problem-solving ability of nursing students, although the delivery method differed. In an Iranian pilot study, CBL has been reported effective on critical thinking, clinical decision making, and stress management skills of nursing students,[29] which is consistent with the results of the present study, although they have not directly measured problem-solving ability by a valid assessment tool. In another study in Turkey, 13 clinical scenarios about perineal care, oral drug administration, and respiratory applications were provided to nursing students, compared with the control group who received a traditional education, and the results showed that the decrease in PSI dimensions was not statistically significant,[30] which is contrary to the results of the present study. This difference in the results of studies implies that the quality of the provided education is important on the effectiveness of the educational intervention on nurses' problem-solving ability. In the present study, the educational content was designed carefully and with great proficiency and reviewed by several specialists as well as higher-level students, in order to decrease its inefficiencies and the results showed that it had favorable results.

Limitations and recommendation

One of the limitations of the present study was the lack of a control group to compare the results with. Another limitation was related to the small number of students, nonrandomized inclusion of students from one educational center, and targeting only one course (nutrition), which reduce the generalizability of the results to the whole population and other fields. In addition, we only evaluated the outcome of the intervention quantitatively, while qualitative assessment of the effect of this educational method will be valuable, as well. We also did not evaluate the long-term results of the intervention.

Conclusion

This study showed that the CBEL method, designed by the specialists and reviewed by several teams, had a positive effect on the ability to solve the learning problems of nursing students in the field of nutrition and could also improve the academic performance of the students; therefore, we suggest that this method can be used to train nurses for improving their ability to confront the clinical problems in future.

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Conflicts of interest

There are no conflicts of interest.

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