Original Article

Effectiveness of cardiopulmonary bypass device educational program using painting and group discussion based on the Kirkpatrick model

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Article Info

Article history:
Received 18 Dec. 2022
Accepted 19 April. 2023
Published 17 May. 2023

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How to cite this article:
Borusan B, Salajegheh M, Dahesh T. Effectiveness of cardiopulmonary bypass device educational program using painting and group discussion based on the Kirkpatrick model. J Med Edu Dev. 2023; 16(50): 1-6.

Abstract

Background & Objective: Clinical education has a very important contribution to the educational process of medical science students. Simple and understandable methods help to learn complex clinical processes, such as cardiopulmonary bypass device. The present study aimed to assess the effectiveness of the cardiopulmonary bypass device educational program using painting and group discussion for anesthesiology students based on the Kirkpatrick model.

Materials & Methods: This quasi-experimental study was conducted on 30 undergraduate anesthesiology students. The intervention group (n=15) were trained on cardiopulmonary bypass device by painting and group discussion, and the control group (n=15) received common education. Pretest and posttest data were collected in the two studied groups using a researcher-made questionnaire to evaluate the reaction and learning. The data were analyzed in SPSS software.

Results: At the reaction level, there was no statistically significant difference between the two groups. At the learning level, the mean score of knowledge in the intervention group changed significantly compared to the control group.

Conclusion: As evidenced by the obtained results, the educational program of cardiopulmonary bypass device using painting and group discussion resulted in positive outcomes in the two evaluated levels of reaction and learning.

Keywords: Cardiopulmonary Bypass, Kirkpatrick Model Medical Education.

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Introduction

Public health is dependent on high-quality medical education, and especially clinical education has a very significant role in this regard. In order to improve public health, clinical education must help students to attain professional competencies. Clinical education plays a critical role in the achievement of not only cognitive learning objectives but also affective and psychomotor domains of learning, such as performing medical tasks independently and clinical decision-making (1). Some studies have suggested that clinical education has not been able to improve students' professional capability appropriately due to some challenges (2). The absence of students interaction and engagement in the learning process, especially in departments with complex surgical procedures and equipment, is one of the daunting challenges (3).

Open-heart surgery is one of the most complicated and vital types of surgery. In recent years, some advancements have been made in cardiac surgery due to the development of cardiopulmonary bypass (CPB). The CPB is a type of extracorporeal circulation that supports blood circulation, respiration, and managing temperature

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[DOI: 10.32592/jmed.2023.16.50.1]

to facilitate surgeries on the heart and great vessels (4). Despite the importance of understanding the open-heart surgery procedure for anesthesiology students, who have a role in these surgeries, the complex function and structure of this device have made it difficult for students to understand these surgeries.

One strategy to improve students' involvement in the learning of complex clinical procedures is visualizing educational content (5, 6). In this regard, various methods, such as static or dynamic pictures and virtual imaging, have been recommended; nonetheless, the related studies suggest that these methods need complex and expensive technical equipment in many cases (7). Painting has increasingly been considered in clinical education (8). Some previous studies have used painting as an accurate and simple representation of reality to teach anatomy, surgical methods, or therapeutic procedures (9, 10).

Junhasavasdikul et al. (2017) reported that the medical students who had been taught the intercostal drainage procedure using cartoon pictures achieved a higher posttest score than those who had been taught using the common methods (11). Mukunda et al. (2019) indicated that the application of visual arts in medical curricula improves the quality and durability of diagnostic skills. They recommended the application of visual arts in medical students' clinical education curriculum (12). Furthermore, one of the fundamental learning theories in medical education is the sociocultural theory proposed by Lev Vygotsky (1978). According to this theory, learning is achieved through conversation and interaction with others (13). Based on this theory, group discussion can be utilized in teaching complex clinical procedures.

The complex function and structure of the CPB device have made its instructions ambiguous for students in the cardiac surgery room. Probably, the most efficient teaching methods for this device are those providing interaction and conversation between students and instructors using painting and group discussion(14). In addition, there is a need to evaluate the effectiveness of these teaching methods. Educational program evaluation is a dynamic method to identify the challenges, strengths, and ways to improve the program (15).

One of the practical and efficient models in program evaluation is Kirkpatrick's model, in which the effectiveness of an educational program is evaluated at four levels: reaction, learning, behavior, and result. The reaction level evaluates the participant's satisfaction with the educational program. The learning level determines the knowledge and skills learned by the participants. At the third level, participants' behavioral changes resulting from the program are studied. Finally, the resulting level determines the effectiveness of the program in organizational indices (16).

Considering the significance of learning the structure and function of the CPB device for anesthesiology students, the present study aimed to evaluate the effectiveness of the Cardiopulmonary Bypass device educational program using painting and group discussion for anesthesiology students based on the Kirkpatrick model.

Materials & Methods

Design and setting(s)

It was a quasi-experimental study with a nonrandomized control group pretest-posttest design (17), as illustrated in Figure 1. It was conducted at Kerman University of Medical Sciences from September 2021 to January 2022.

Class	pretest	treatment	posttest
Experimetal	O	X1	O
Control	O	X2	O

Information:
O: pretest or posttest of mathematical creative thinking ability
X1: Learning Using Monopoly Game Media-Based Course Review Hoary (CRH) Model
X2: Conventional Learning

Figure 1. Research Design of Nonrandomized Pretest-Posttest Control Group

Participants and sampling

The study was conducted on 30 anesthesiology students studying internship in the cardiac operation room (n=30). The inclusion criteria entailed all the final-year anesthesiology students with cardiac operating room rotation in their internship program. Students who could not attend the internship at the specified time due to personal issues were excluded from the study.

The students were randomly assigned to the control group (n=15) and intervention group (n=15). Each group was then divided into subgroups (n=3 or 4) that would take part in the internship program in the cardiac operating room. It is worth noting that the researchers tried to ensure that all the people in the intervention group were trained in the same way only through painting and group discussion and did not receive any other training. The students had passed the same clinical courses in similar educational conditions before the initiation of the study and were not aware of the grouping details until the beginning of their internship.

Tools/Instruments

A questionnaire was designed and psychometrically evaluated to measure the students' satisfaction and

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[DOI: 10.32592/jmed.2023.16.50.1]

learning based on the Kirkpatrick model. This questionnaire consisted of three parts. In the first part, the student's demographic information (age and gender) was collected. The second part consisted of 15 multiple-choice questions regarding their satisfaction with the educational program in the three domains of administration, goals, and content of the program, and instructor's teaching, which were assessed using a 5-point Likert scale including 1 = Strongly disagree, 2 = Disagree, 3 = No comment, 4 = Agree, and 5 = Strongly agree. In the third part of the questionnaire, students' learning was studied using 15 multiple-choice and short-answer questions prepared based on the lesson plan of the CPB device.

The content validity, face validity, and reliability were investigated for the psychometrical evaluation of the questionnaire. Content validity was checked by calculating the content validity ratio (CVR) using Lawshe's method and the content validity index (CVI) using Waltz & Bausell's method. Face validity was also examined using experts' opinions regarding fluent writing, simple and understandable words, and avoiding technical words. The reliability of the questionnaire was analyzed using Cronbach's alpha to determine the internal consistency. The overall CVR was 0.69, which was acceptable. The CVI for all items was 0.79. Some items were corrected after face validity. The cronbach alpha coefficient for all items of the questionnaire was 0.83.

Data collection methods

Before the intervention, the pretest was conducted for both control and intervention groups by completing the questionnaire. For the intervention group, on the first day of the cardiac rotation, some paintings of the CPB device's structure and function were presented. These paintings included the device's parts, blood circulation path in the tubes, and heart chambers, details such as the proportion between the parts and the size of the tubes, and the coloration of oxygenated and deoxygenated blood. The paintings were prepared by CPB experts and depicted the details of the device simply with precise and appropriate coloring. Afterward, the instructor provided complementary explanations, and the students discussed the paintings, and the instructor answered to their questions. In the control group, like in the previous programs, the instructor only provided some explanations about the CPB device and answered the students' questions. The stages of painting and group discussion were done according to previous studies (18, 19).

Data analysis

At the end of the cardiac rotation, a posttest using the questionnaire was conducted for both groups to evaluate students' satisfaction and learning. Data were analyzed in SPSS software (version 280 using an independent t-test and ANCOVA.

Results

All 30 anesthesiology students (15 in the intervention group and 15 in the control group) who completed the posttest underwent the final analysis. In terms of gender, most participants were female (73%; n=22). Regarding age, the students were in the age range of 23-26 years. Intervention and control groups were similar in terms of demographic variables (age and gender), and no significant differences were found between the groups.

At the reaction level of the Kirkpatrick model, the mean and standard deviation of the student's satisfaction score was 71.76±4.29 in the control group. In terms of administration, goals and content, and instructor's teaching, the mean and standard deviations were 12.03 2.97, 22±2.92, and 31.90±3.12, respectively. In addition, the intervention group's mean and standard deviation of satisfaction with the program was 71.73±4.61. The mean and standard deviations of administration, goals, and contents, and instructor's teaching were 12.20±2.80, 23.2±1.85, and 32.08±295, respectively. The independent t-test showed no significant statistical relationship between the satisfaction scores of the two groups (P= 0.751), and both groups were satisfied with the program (Table 1).

Table 1. The comparison between the students' reaction to the educational program in control and intervention groups

Group	Mean±SD[a]	*P.Value
Intervention group	71.73±4.61	0.751
Control group	71.76±4.29	

a: Standard division
*: Independent t-test

At the learning level of Kirkpatrick model, the student's learning scores changed significantly in the intervention group. The mean of changes in students' knowledge increased by 5.93 and 4.79 in the intervention and control groups, respectively. The results of the independent t-test revealed that the mean scores before and after the interventions were significantly different (P=0.001), and the educational program had been efficient in improving the learners' knowledge. Furthermore, comparing the

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[DOI: 10.32592/jmed.2023.16.50.1]

painting and group discussion method with the common teaching method showed that the intervention had been effective according to ANCOVA (P= 0.049). The students learned better through group discussions and the use of painting compared to the control group. The required assumptions for ANCOVA were examined, and there was no interaction between the pretest and posttest scores in the group (P=0.114). Moreover, the variance was homogeneous in both groups (P=0.860) (Table 2)

Table 2. Comparison of pretest and posttest scores in the control and intervention groups

Groups		Mean±SD[a]	*P.Value	**P.Value
Intervention group	**Before the intervention**	6.47±2.64	0.001>	0.049
	After the intervention	12.40±2.23		
Control group	**Before the intervention**	6.57±2.17	0.001>	
	After the intervention	11.36±2.09		

a: Standard division
*: Independent t-test
**: ANCOVA

Discussion

The present study evaluated the effectiveness of the Cardiopulmonary Bypass device educational program using painting and group discussion for anesthesiology students based on the Kirkpatrick model. Consistent with the results of previous studies, in this research, the level of student's satisfaction with the educational program of the CPB device using drawing and group discussion was reported to be higher in the intervention group than in the control group. Kari et al. (2019), in a study on the effect of painting on medical students' understanding of the radiology profession, concluded that paintings can challenge negative stereotypes that medical students have in the radiology profession, and this arts-based learning module should be considered by the radiology profession as a strategy to positively inform and educate trainees about the specialty (20).

The changes in students' learning were investigated by comparing the learners' knowledge before and after the program. The students' learning with painting and group discussion indicated a great increase compared to traditional education. These results were in agreement with the findings of the study by Junhasavasdikul et al. (2017) on the effectiveness of cartoon handouts compared with traditional handouts in preclinical students' learning. They described the participants who received cartoon-style education read more of the material and achieved higher post-learning test scores than students given a traditional handout (11). Moreover, Kari et al. (2019) assessed the effectiveness of paintings of radiology on medical students' understanding and impression of both radiologists and the radiology profession and reported that 82% of participants found the painting experience "very enjoyable" and 96% would recommend this session to others (20).

Group discussion as a teaching method is based on the social constructivism theory. According to this theory, knowledge and understanding occur based on conversation and interaction with others in social settings. Vygotsky emphasizes the significance of thinking, reflection, talking, and practicing for knowledge-building (21, 22) . According to the findings of the present study, group discussion helped students understand the information they received from the paintings related to the CPB device by providing opportunities for conversation. These results were consistent with the previous studies. Qureshi (2021) introduced the application and advantages of social constructivism theory in medical education and described this theory as a beneficial approach at undergraduate and postgraduate levels of medical education (21).

Many educational programs are designed and performed in medical universities every year about different subjects of cardiac care, including cardiopulmonary resuscitation, interpreting electrocardiograms, and introducing new equipment (23, 24). Nevertheless, no research has been published on the assessment of CPB device education (25). The evaluation of the effectiveness of an educational program provides valuable feedback for developing and improving teaching methods (16). In this study, we achieved desirable results regarding the paintings and group discussion as efficient teaching methods by evaluating students' satisfaction and learning.

There are some limitations to the study. Firstly, it was conducted in only one university, which can reduce the generalizability of the results. However, embedding the program in a theoretical framework and utilizing an evaluation model in the interpretation of the results may greatly diminish this limitation. Secondly, all evaluations

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[DOI: 10.32592/jmed.2023.16.50.1]

were based on students' perceptions, which is a potential source of bias about the outcomes of the educational program. We, therefore, recommend using other insights, such as the perceptions of instructors and heart operation room staff.

Conclusion

The Cardiopulmonary Bypass device educational program using painting and group discussion was able to attract more students' attention and resulted in a higher post-learning test score when compared with a common teaching method. Furthermore, this teaching method may benefit the human resource developers in improving the skills of heart operation staff. We hope that our research will encourage medical educators to consider using painting materials and undertake further research to assess their effectiveness and popularity with students.

Ethical considerations

This study was approved by the Ethics Committee of Kerman University of Medical Sciences (No: IR.KMU.REC.1404.164). Participants did not receive any incentives, and participation was voluntary. Verbal and written consent for participation was obtained based on the proposal approved by the ethics committee. The participants were also assured of the confidentiality of their information, and it was explained that the results would only be used for research objectives. This study was conducted with the legal support of the Vice-Chancellor for Research and Technology of Kerman University of Medical Sciences (Project Number: 400000872). The researchers didn't receive any funding for this study.

Acknowledgment

We would like to thank the colleagues and students who participated in this study for their support and involvement.

Conflict of interest

The authors declare that they have no conflict of interest.

Author contributions

BB and MS formulated the research idea. BB implemented the intervention and collected data. TD performed the analysis. BB and MS interpreted the data and wrote the manuscript. All authors approved the final manuscript.

Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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