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Original Article

Effect of flipped classroom on medical students' semiology knowledge and skills

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Abstract

Introduction: Flipped classrooms make learners eager to learn actively. it is based on learner-based and active learning methods. The flipped classroom is an educational strategy and a kind of hybrid learning that turns education into a learner-based model in which the class time is spent exploring topics and creating engaging learning opportunities.

Methods: During an interventional quasi-experimental research, 90 medical students entered the study. The intervention and control group received flipped classroom and traditional education, respectively. The knowledge and skills of the participants were assessed by a standard checklist approved by the Ministry of Health. Data analysis was done by analytical statistical test after data collection.

Results: the mean score of students' knowledge in performing adult examination, obtaining medical history, and pediatric examinations in all three areas between the two groups after the intervention and two months later was statistically significant ($P<0.001$). there was a statistically significant difference between the mean scores of students' skills in performing adult examinations in all three areas ($P\leq0.001$) so that the mean skill score of adult examinations was higher in the intervention group than the control group. there was a statistically significant difference between the mean scores of students' skills in obtaining medical history ($P\leq0.001$) so that the mean skill score of obtaining medical history was higher in the intervention group than the control group. Also, there was a statistically significant difference between the mean scores of students' skills in performing pediatric examinations ($P\leq0.001$) so that the mean skill score of pediatric examinations was higher in the intervention group than the control group.

Conclusion: Flipped classroom increases knowledge, improves skills in instructing practical semiotics to medical students of physiopathology grade.

Introduction

The flipped classroom is a relatively new approach in the world.[1] This approach makes learners eager to learn actively.[2,3] A definition of a flipped classroom by Lage et al, includes events that traditionally took place inside the classroom and now are moved to the outside of the classroom and conversely. Thus, flipped classroom is based on learner-based and active learning methods.[4] The flipped classroom is an educational strategy and a kind of hybrid learning that turns education into a learner-based model in which the class time is spent exploring topics and creating engaging learning opportunities.[5] Meanwhile, more time might be spent in the classroom on thinking skills. Furthermore, learners' activities revolve around learning, creating more knowledge, and evaluating their knowledge.[6] According to the results of studies, learners' inferences from flipped classroom methods have been positive. They prefer to have video lectures in a visual form and more classroom interactive activities.[7,8]

Medical education needs a fundamental transformation to enhance clinical decision-making potentials by applying new instructing methods. Strengthening student-centered learning, lead to the development of self-employed graduates and creative thinkers ready for complex medical practice.[9] Any level of education can lead to learning, but the depth and stability of different methods are not the same. Instead of traditional lectures, through flipped classroom model learners watch videos of recorded lectures at any possible time and place before the classroom and do their pre-class assignments, thus they would be ready for cooperative education in the classroom.[8,10-14] The class time is also spent on active learning activities such as individual exercises, small group exercises, and practice on simulators, discussions,

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and case studies. Thus, unlike traditional lecture, in this approach, the learner will not be simply a passive recipient of content.[15,16] The attractively of this model for individuals with different learning styles is considered as one of its advantages. The flipped classroom increases the learners' engagement in a variety of ways including pre-class video watching, participating in cooperative activities, active learning, and interaction with the instructor through class activities. Hence, it has the potential of giving importance to the different learning styles of learners.[17] Through this method, the instructor's role shifts from the information transmitter to a facilitator and advisor and plays a more cooperative role by giving personal feedback to the learners.[18]

The semiotics course is instructed theoretically and practically through the cooperation of clinical departments and the Clinical Skill Laboratory. It is one of the most important courses that medical students often spend among other internship courses. According to Missildine et al, the mean test scores of students in the flipped classroom group were higher than the students of simple traditional lecture and traditional lectures with video, while the satisfaction of the students in the flipped classroom was lower than the other two groups.[10] Unlike this study, Mikkelsen reported high satisfaction of the learners of the flipped classroom.[19] The study of Harrington et al in 2015, shows the mean scores of 3 tests, 24 quizzes, and a written test of the flipped classroom group were higher than the lecture group among nursing students. However, this difference was not statistically significant.[20] the importance of learning clinical examinations, obtaining a medical history, dealing with the patient before admission in the hospital wards, the need to organize semiotics, and giving importance to this course as the basis of clinical education led us to present semiotics in flipped classroom method.

Methods

In interventional quasi-experimental study, the research site was the Clinical Skills Center of Tabriz Medical School and the inclusion criteria were medical students of physiopathology course. According to the study of Jafaraghaie et al[11] the sample size was 45 subjects in each group. Medical students of physiopathology course spent 5 to 7 practical credits of semiotics both in the hospital as education on real patients and in the clinical skills center under the supervision of the relevant internal professor (internship in the hospital) through practicing on the simulated patient and medical moulage in the skill lab. The study samples were randomly divided into intervention and control groups and received flipped and traditional educations, respectively. The traditional method was according to the previous routine, in which theoretical and practical instruction was done by the instructor of the semiotics course at the Clinical Skills Center. While in flipped method, the educational content of the practical course of semiotics (educational booklet, videos of examination and obtaining medical history, and PowerPoint presentations) were provided for the intervention group via the skill lab website (https://www.tbzmed.ac.ir/) at least one month in prior, then the students of the intervention group practiced and discussed on the simulated patient and medical moulage under supervision of the relevant professor. At the beginning and end of the intervention (two weeks after practice), students' performance was assessed by a standard checklist approved by the Ministry of Health as an objective structural clinical examination (OSCE). The control group did not receive any educational content and both theoretical and practical education was performed during the class and at the skill lab. The OSCE test was taken before the education and after it (two weeks later). At the time of the OSCE test, the evaluators were single-blind. All the used instruments were standard checklists approved by the Ministry of Health, which are used in tests of medical students' clinical competency, thus there was no need for validity and reliability. Finally, using SPSS software version 20, the data analysis was done through descriptive statistical methods (including tables, graphs, and calculation of statistical indices of mean and standard deviation) and analytical statistics (statistical tests such as t-test and univariate and multivariate regression, analysis of variance). Due to the normal distribution of data, parametric and non-parametric tests were used in the analytical statistics.

Results

A total of 90 medical students participated (physiopathology) in this study of which 45 students received flipped semiotics education and the other 45 students as a control group, received traditional practical semiotics education. Of all students, 46 individuals (51.1%) were male and 44 (48.9%) were female. Students participating in the intervention and control groups were 23 (51.1%) male and 22 (48.9%) female. There was no statistically significant difference between the gender ratio in the two groups ($P > 0.99$).

Students' knowledge in performing adults' cardiac and pulmonary, head and neck, abdominal examinations

The mean (standard deviation) of students' knowledge in performing the pre-education cardiac and pulmonary examination in the intervention and control groups was 5.88 (1.33) and 5.46 (1.53), respectively. The results of the independent t-test showed that there was no statistically significant difference between the mean score of cardiac and pulmonary examination between the two groups ($P = 0.16$). The mean (standard deviation) of students' knowledge in performing pre-education head and neck examination in the intervention and control groups was 4.88(1.26) and 4.41 (1.03), respectively. The results of the independent t-test showed that there was no statistically

significant difference between the mean score of head and neck examination between the two groups ($P=0.44$). The mean (standard deviation) of students' knowledge in performing the pre-education abdominal examination in the intervention and control groups was 5.04 (1.02) and 5.01 (1.44), respectively. The results of the independent t-test showed that there was no statistically significant difference between the mean score of abdominal examination between the two groups ($P=0.23$). Table 1 indicates the mean and standard deviation of students' knowledge score of both groups in adult examinations before the intervention, after the intervention, and two months later.

According to Table 1, the mean knowledge score of the intervention group in adult examinations in all three areas after the intervention and two months later was higher than that of the control group. The results of the independent t-test showed that the mean score of students' knowledge in performing adult examinations in all three areas between the two groups after the intervention and two months later was statistically significant ($P<0.001$).

Students' knowledge in obtaining medical history

The mean (standard deviation) of students' knowledge in obtaining medical history before education in the intervention and control groups was 6.82 (2.33) and 6.25 (2.70), respectively. The results of the independent t-test showed that there was no statistically significant difference between the mean score of obtaining medical history between the two groups ($P=0.11$). Table 2 indicates the mean and standard deviation of students' knowledge score of both groups in obtaining medical history before the intervention, after the intervention and two months later.

According to Table 2, the mean knowledge score of the intervention group in obtaining medical history after the intervention and two months later was higher than that of the control group. The results of the independent t-test showed that the mean score of students' knowledge in obtaining medical history between the two groups after the intervention and two months later was statistically significant ($P<0.001$). Figure 1 shows the mean knowledge score of obtaining medical history in three periods. Based on paired t-test, the difference between the mean knowledge score of obtaining medical history of the

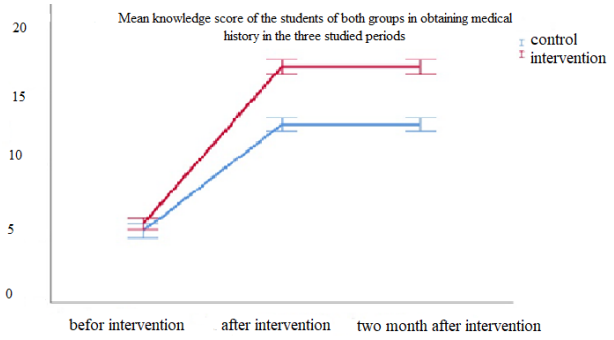

Figure 1. Mean knowledge score of the students of both groups in obtaining medical history in the three studied periods

Table 1. Mean knowledge score of the students of both groups in performing adult examination in the three studied periods

Period	Group				*P* value
	Control		Intervention		
	Frequency	Mean ± standard deviation	Frequency	Mean ± standard deviation	
Cardiac and pulmonary examination knowledge before intervention	45	5.64 ± 1.53	45	5.88 ± 1.33	0.167
Cardiac and pulmonary examination knowledge after intervention	45	11.66 ± 1.55	45	16.33 ± 1.25	<0.001
Cardiac and pulmonary examination knowledge two months after intervention	45	12.83 ± 1.03	45	17.44 ± 1.55	<0.001
Head and neck examination knowledge before intervention	45	4.41 ± 1.03	45	4.88 ± 1.26	0.167
Head and neck examination knowledge after intervention	45	13.93 ± 1.28	45	18.03 ± 1.05	<0.001
Head and neck examination knowledge two months after intervention	45	12.83 ± 1.43	45	17.03 ± 14463	<0.001
Abdominal examination knowledge before intervention	45	5.01 ± 1.44	45	5.04 ± 1.02	0.167
Abdominal examination knowledge after intervention	45	12.83 ± 1.55	45	18.03 ± 1.43	<0.001
Abdominal examination knowledge two months after intervention	45	13.83 ± 1.55	45	18.03 ± 1.37	<0.001

Table 2. Mean knowledge score of the students of both groups in obtaining medical history in the three studied periods

Period	Group				*P* value
	Control		Intervention		
	Frequency	Mean ± standard deviation	Frequency	Mean ± standard deviation	
Obtaining medical history knowledge before intervention	45	6.25 ± 2.70	45	6.82 ± 2.33	<0.11
Obtaining medical history knowledge after intervention	45	11.63 ± 1.57	45	16.03 ± 1.46	<0.001
Obtaining medical history knowledge two months after intervention	45	11.74 ± 1.56	45	16.23 ± 1.74	<0.001

intervention group after education and two months later was not statistically significant ($P > 0.71$).

Students' knowledge in performing the general pediatric examinations

The mean (standard deviation) of students' knowledge in obtaining the general pediatric examination before education in the intervention and control groups was 3.36 (1.73) and 3.44 (1.69), respectively. The results of the independent t-test showed that there was no statistically significant difference between the mean score of the general pediatric examination between the two groups ($P = 0.77$). Table 3 indicates the mean and standard deviation of students' knowledge score of both groups in the general pediatric examination before the intervention, after the intervention, and two months later.

According to Table 3, the mean knowledge score of the intervention group in the general pediatric examination after the intervention and two months later was higher than that of the control group. The results of the independent t-test showed that the mean score of students' knowledge in the general pediatric examination between the two groups after the intervention and two months later was statistically significant ($P < 0.001$). Figure 2 shows the mean knowledge score of the general pediatric examination in three periods. Based on paired t-test, the difference between the mean knowledge score of the general pediatric examination of the intervention group after education and two months later was not statistically significant ($P > 0.66$).

Students' skills in performing adult examinations (cardiac and pulmonary, head and neck examination, and abdominal examinations)

According to Table 4, the analysis of variance, repeated measures of changes in the mean score of students' skills in performing adult examinations were not significant

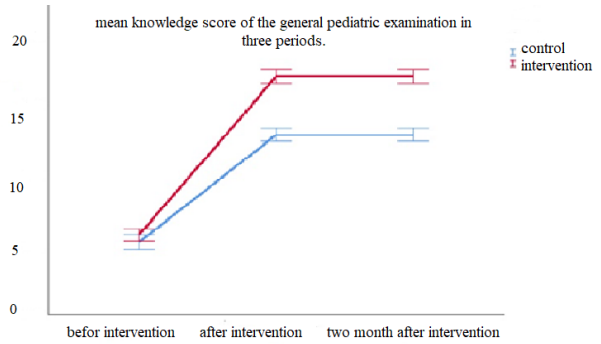

Figure 2. mean knowledge score of the general pediatric examination in three periods.

Table 3. Mean knowledge score of the students of both groups in the general pediatric examination in the three studied periods

Period	Group				*P* value
	Control		Intervention		
	Frequency	Mean ± standard deviation	Frequency	Mean ± standard deviation	
General pediatric examination knowledge before intervention	45	3.44 ± 1.69	45	3.36 ± 1.7	< 0.77
General pediatric examination knowledge after intervention	45	11.56 ± 2.33	45	15.04 ± 2.39	< 0.001
General pediatric examination knowledge two months after intervention	45	11.57 ± 2.49	45	15.04 ± 2.44	< 0.001

Table 4. Mean skill score of the students of both groups in performing adult examination, obtaining medical history and performing pediatric examination after the intervention, and two months later

Period	Group			
	Control		Intervention	
	Frequency	Mean ± standard deviation	Frequency	Mean ± standard deviation
Mean skill score of the students of both groups in performing adult examination				
Cardiac and pulmonary examination skill after intervention	45	13.45 ± 2.23	45	18.03 ± 1.11
Cardiac and pulmonary examination skill two months after intervention	45	14.66 ± 2.23	45	18.66 ± 2.03
Head and neck examination skill after intervention	45	11.03 ± 2.65	45	16.25 ± 2.11
Head and neck examination skill two months after intervention	45	12.47 ± 2.12	45	17.01 ± 2.66
Abdominal examination skill after intervention	45	12.44 ± 2.34	45	18.87 ± 1.16
Abdominal examination skill two months after intervention	45	13.51 ± 2.76	45	18.08 ± 2.06
Mean skill score of the students of both groups in obtaining medical history				
Obtaining medical history skill after intervention	45	7.24 ± 7.07	45	13.29 ± 3.86
Obtaining medical history skill after intervention	45	7.24 ± 7.07	45	13.29 ± 3.86
Mean skill score of the students of both groups in performing pediatric examination				
Pediatric examination skill after intervention	45	11.09 ± 2.22	45	14.22 ± 2.16
Pediatric examination skill two months after intervention	45	10.83 ± 2.17	45	15.3 ± 2.33

over time ($P=0.66$). Also, there was a statistically significant difference between the mean scores of students' skills in performing adult examinations in all three areas ($P \leq 0.001$) so that the mean skill score of adult examinations was higher in the intervention group than the control group.

Students' skill in obtaining medical history

According to Table 4, the analysis of variance, repeated measures of changes in the mean score of students' skills in obtaining medical history were significant over time ($P<0.001$) so that the mean score of this skill was increasing in both groups. The interaction between the period and the study group was not statistically significant ($P=0.57$). Also, there was a statistically significant difference between the mean scores of students' skills in obtaining medical history ($P \leq 0.001$) so that the mean skill score of obtaining medical history was higher in the intervention group than the control group.

Students' skills in performing pediatric examinations

According to Table 4, the analysis of variance, repeated measures of changes in the mean score of students' skills in performing pediatric examinations were not significant over time ($P=0.30$). The interaction between the period and the study group was not statistically significant ($P=0.10$).

Also, there was a statistically significant difference between the mean scores of students' skills in performing pediatric examinations ($P \leq 0.001$) so that the mean skill score of pediatric examinations was higher in the intervention group than the control group.

Discussion

According to the results, there was no statistically significant difference between the two groups in the mean knowledge scores of adult examinations, obtaining medical history, and pediatric examinations before education. The mean score of knowledge in performing the three skills after the intervention and two months later was higher in the intervention group than in the control group. The mean skill scores of adult examination, obtaining medical history, and pediatric examinations of the intervention group were higher than the control group, all of which show the positive effect of flipped classroom on learning the practical semiotics by medical students.

Educating through a course, more reliance on practical and theoretical education, and making theoretical issues more understandable through using teaching aids and skill lab facilities in the semiotics course leads to learners' satisfaction with and greater impact of this education method. The flipped classroom is an advanced and effective curriculum model that allows learners to process information before the class and use this information in the class through discussions and group activities while the relevant professor plays the role of a facilitator.[18]

Considering the priority of educating the care of patients, it seems crucial to pay attention to the use of new educational methods that may provide the basic needs for creative and self-effective thinking with a high potential to solve problems. Also, the results of a study by Gilboy et al in which the flipped classroom was used to teach nutrition courses to nutrition students, showed similar results.[21] Critz and Knight[22] and Schwartz[23] instructed some the nursing course through the flipped classroom. The results of their studies indicated high satisfaction of learners with this method. Moreover, the learners have been reported to be highly satisfied with the flipped classroom in other disciplines such as occupational therapy education.[24]

In this study, the mean knowledge and skill scores of the intervention group were higher than the control group after the intervention two months later. In line with the results of this study, Missildine et al[10] reported that the mean test scores of students in the flipped group were higher than those in the groups of simple traditional lecturing and traditional lecturing by video, however, the satisfaction of students of the flipped classroom was lower than the other two groups.[9] Yet, Mikkelsen reported high satisfaction of learners with the flipped classroom.[19] The results of a study by Harrington et al in 2015, the mean scores of 3 tests, 24 quizzes, and a written test of the flipped classroom group were higher than the lecture group among nursing students. However, this difference was not statistically significant.[20]

Conforming the results of the present study, the results of a study by Namdar et al indicated the possibility of deeper learning by instructing the immunology course in flipped class through learning motivation, interaction, and discussion between learners, and the relationship between pre-class and in-class activities.[25] In an interventional study aimed at comparing the traditional and flipped classroom methods in cardiovascular resuscitation skills education, Nakanishi et al reported no significant difference between the results of the two groups. Yet, the required resources for flipped classroom method were less than the traditional one, and it is a student-centered education method without any interference in the learning of resuscitation skills.[26] Boysen-Osborn et al stated that flipped classroom significantly improved test results (multiple-choice questions (MCQ), fill-in clinical cases).[27] Hence, all the studies confirm the results of the present study.

According to Ramnanan and Pound, recently, the use of flipped classroom method for instructing undergraduate medical education has increased. In flipped classroom curriculum (FC), students are initially exposed to content through online resources. Therefore, the face-to-face class time might be allocated to student-centered activities which promote active learning. Generally, medical students appreciate pre-class preparation activities (particularly when facilitated by concise, easy-

to-access online tools) as well as interactive activities in small groups. Some students have stated concern about FC. In their opinion, the under-optimal student readiness and adequate direction and structure in active learning sessions may limit student-centered benefits. Although students generally understand that FC approaches can improve their learning and knowledge, this has not been conclusively depicted in the implementation assessment instruments, which may be relevant to precautionary measures used with these instruments. Nevertheless, self-learning lifelong skills that are understood by medical students might be enhanced by FC. Finally, medical students were generally satisfied with the initial FC programs for postgraduate medical education and they preferred this method to lecture-based education.[28]

Conclusion

The flipped class method increases knowledge and skills in instructing practical semiotics of cardiac and pulmonary, abdominal, and head and neck examinations to physiopathology medical students. Due to the use of the flipped method in instructing clinical skills in this research, it is suggested to examine the views, attitudes, and satisfaction of students and professors of the flipped classroom method in performing clinical skills.

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Competing Interests

No conflict of interest has been declared by the authors.

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