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Does the sequence of flipped and lecture-based classes affect the academic achievement and satisfaction of medical students?

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Abstract

In a flipped classroom, class' lecture is delivered as a video to students before the class is held, and the actual time of the class is spent on problem solving and discussions. As there is a need for further clarification of the way of using this method, in this study, we assessed the effect of the sequence of flipped and lecture-based classes on medical students' learning and satisfaction in Emergency Medicine theoretical course. For this purpose, 59 medical students participated in this quasi-experimental study who were divided into two flipped-first and lecture-first groups. Eight topics were selected to be taught. Firstly, students took a pre-test covering these topics' objectives. Afterward, in the lecture-first group, 4 topics were taught through lecturing while the next 4 topics were taught through flipped classroom method. Then the teaching method was shifted for the flipped-first group. Finally, students answered the satisfaction survey and post-test questions. Indeed, not only the final score of the flipped-based topics in both groups was significantly higher than lecture-based ones (P-value = 0.022), but also the post-test score of all topics were significantly higher in the flipped-first group (P-value = 0.032). In addition, the satisfaction score for the flipped-based topics was higher than the lecture-based one (P-value = 0.011). As a conclusion, flipped classroom approach could increase medical students' learning as well as their satisfaction and it is recommended that flipped classes be applied from the beginning of the course to be more effective.

KEYWORDS: Teaching Methods, Learning, Flipped Classroom, Emergency Medicine, Satisfaction

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1. Introduction

Lecturing, as the most common method of teaching medical courses (Alluri, Tsing, Lee & Napolitano, 2016), is a teacher centered strategy in which students tend to be passive and learn superficially (Afurobi, Izuagba, Obiefuna & Ifegbo, 2015). In fact, a lecture is *"a talk or verbal presentation with the help of audio-visual aids like black board, charts, etc."* (Bala, Kaur & Kaur, 2017). Meanwhile, this teaching method is useful for teaching essential clusters of knowledge in medical curricula at all levels and in almost all schools and universities (Kaur, 2011). In fact, lecturing has some advantages. It allows teachers to precisely organize their syllabus through defining the objectives, content, pace and theme of the presentation. In addition, it serves as a good mean for clarifying textbooks' contents and at the same time addressing almost all students at once. On the

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other hand, teachers should have effective and powerful speaking and writing competencies in order to be able to deliver a good lecture. Besides, during a lecture session, the teacher is the main provider of information to the students which could lead to a low interactivity among class' participants and students' differences ignorance (Bala et al., 2017; Bove, 2008). These limitations bring medical educators to use different teaching strategies in order to make students "think, find reasons, compare, analyze issues, evaluate and make decisions" (Docherty CHoy, Topp & Trinder, 2005).

In this regard, with the advent of technology, educational systems have undergone various changes, one of which is modification in teaching methods. Indeed, technology provides more possibility for substituting traditional teacher centered teaching methods with more interactive student centered ones (Bala et al., 2017). Flipped classroom, posed by Bergman and Sams in 2007 (Enfield, 2013), is one of these methods that has received much attention in medical education recently (Chen, Lui, Martinelli & Chen, 2017). In flipped classroom, the activities that students do in the class and home are exchanged. In routine classes, students receive the lectures containing the course content in the class and do the assignments at home (Pettit, McCoy & Kinney, 2017). Whereas in this method students study and learn the lecture's content at home before the class and the face to face class is devoted to student centered activities like problem-based learning and group discussions (Tang et al., 2017). Hence, during the face-to-face part of flipped classes teachers are the facilitator of the students' learning and play the role of "guide on the side", in contrast to traditional lecture-based sessions where the teachers play the role of "sage on the stage". Actually, this leads to the change of students' role from being passive in lecture-based classes to active in flipped ones (Bishop & Verleger, 2013).

When it comes to the effectiveness of this method in health science's education, there are recent studies that are performed in different disciplines such as nursing (Della Ratta, 2015), pharmacology (McLaughlin et al., 2013), physiology (Street, Gilliland, McNeil & Royal, 2015), radiology (Belfi, Bartolotta, Giambrone, Davi & Min, 2015), dentistry (Park & Howell, 2015) and surgery (Liebert, Mazer, Merrell, Lin & Lau, 2016) which show the satisfaction of both teachers and students and the positive effect of this strategy on students' problem solving, critical thinking and team work skills. To elaborate the importance of such skills, it is worth mentioning that Organization for Economic Cooperation and Development (OECD) considers these skills among the ones that are going to be essential in classrooms and workplaces in 2030 (OECD, 2019). In this regard, more student centered teaching strategies should be applied in curricula to achieve these competencies, (OEDC, 2018). The same is emphasized in some studies supported by European Commission which place these skills among the top ones that are critical for employability (Dall'Amico & Verona, 2015; Vieira et al, 2019). Bringing together the importance of acquiring these competencies and the potential related effect of flipped classroom, makes this teaching strategy as a favorite one to be applied.

On the other hand**,** reviewing the literature still shows some debate on the effectiveness of flipped classroom in medical education (Enfield, 2013; Missildine, Fountain, Summers & Gosselin, 2013; Sawarynski, Eastwood & Iyer, 2013). Just as an example, Whillier and Lystad (2015) showed that the flipped classroom strategy improved neither students' performance nor their satisfaction in learning neuroanatomy, suggesting that this method may not work for studying abstract and memorization-heavy topics.

As there are some instances that flipped classroom is not as effective as it seems to be, performing further research from different views and considering different methodology designs would help medical educationists and teachers to benefit of this method more and more. One of these study questions would be the effect of time of delivering flipped classes during a course, i.e. whether the flipped classes is better to be delivered at the beginning of the course or after some lecture-based sessions. Since we could not find any study related to the above-mentioned question, we performed this study to assess the impact of the sequence of flipped and lecture-based classes on medical students' learning andentirety.

2. Material and method

This quasi-experimental study was performed on medical students who were undergoing a one-month emergency clerkship in six consecutive rotations in 2019. The first three rotations were assigned to the first group of the intervention and the next three to the second one. The first group was given lecture-based sessions at the beginning of the course followed by flipped topics (lecture-first group). In the second group, the topics were firstly presented in flipped format and then in lecture method (flipped-first group). Furthermore, theoretical part of the Emergency Medicine course consisted of 8 topics for each of which the mode of delivery (lecture or flipped methods) was randomly assigned to each group of students, so that for each group four topics were presented as lectures and four topics in the form of flipped classes, and for the next group, the method of presentation was shifted totally, so that students in both groups experienced both methods but in a different sequence.

3. Instructional Design

Two faculty members of emergency medicine department instructed the above mentioned 8 topics which were seizures, burns, syncope, poisoning, multiple trauma, transfusions, opioid poisoning, and decreased consciousness. Firstly, they participated in

two practical workshops on "how to hold flipped classes" and "how to create multimedia contents". Then, the topics were divided between them so that each of them prepared multimedia for four topics, two from the first part and two from the second part of the syllabus. The e-contents were developed with the help of an instructional designer and were in a slide-synchronized with sound format. The average time of each topic was 40 minutes. To develop these products, professors chunked the content of each topic into subtopics which formed the menu for the final product. After preparing the slide presentation, their instructions were recorded in an acoustic studio by a professional staff. Finally, the voices were synchronized with slides and navigation facilities were implemented in the content. Furthermore, some videos of related physical exams and procedures were selected and added to the content if necessary. The produced multimedia contents were evaluated by two other emergency medicine specialists as well. In addition, in order to prepare the contents that had to be delivered before the flipped classes, the teachers designed clinical scenarios related to the topics to be discussed in face to face classes.

4. Intervention

At the beginning of each rotation, students got access to the university's Learning Management system (LMS), where the e-contents were to be uploaded. Then in the introductory session, they were informed of the objectives of the study, got familiar with the flipped classroom method and learnt how to use the LMS. They were also assured that the satisfaction questionnaire was anonymous and that the information was confidential. In addition, students were also told that a pre-test would be taken at the beginning of each topic's class and these tests would affect their final score.

The study began with the lecture-first group (the first three rotations) who took part in four routine lecture-based and then four flipped classes. At the beginning of each session the relevant pre-test was held, and then the topic was presented by the teacher. The lecture method was presented in the conventional way; i.e. the teacher provided information on the topic through lecturing combined with question and answer. In the flipped class approach, teachers uploaded the related e-contents into the LMS one week before each class, so that the students could study the topics by themselves. Afterward, in face to face classes, a brief lecture on e-content was presented after holding the pretest. Then students were encouraged to participate in a discussion about the pre-test questions and predetermined clinical scenarios to resolve the ambiguities. During these sessions, instructors played the facilitator role trying to guide students on applying theoretical knowledge to clinical situations. They also summarized the main lesson concepts at the end of each class. Finally, students took the post-test at the end of the

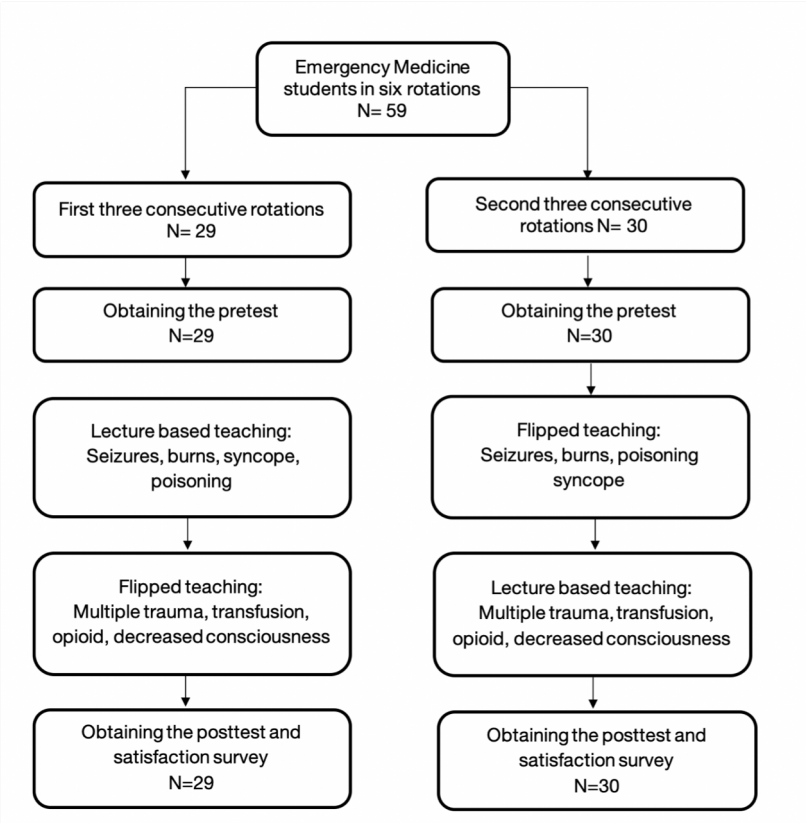

Figure 1 - The diagram of study design in lecture-first and flipped-first study groups.

course that covered the topics of both instructional methods. Figure 1 shows the study design and how the participants and topics' mode of delivery were allocated into the two study groups.

It is worth mentioning that the ethical permission for this intervention was obtained from the university's ethics' committee.

5. Pre and Post-tests and Satisfaction Questionnaire

The pre and post-tests included two different sets of thirty multiple choice questions that covered the syllabus' objectives. Two other emergency medicine specialists rather than the topics' instructors, assessed both tests to confirm their same level of difficulty and objective coverage. Also, the satisfaction questionnaire used in this study was a researcher-made one which consisted of eight items based on a five-point Likert scale (strongly disagree, disagree, neither disagree nor agree, agree and strongly agree) with a score of 1 to 5. In order to validate the questionnaire, it was given to seven experts. Besides, in order to evaluate its internal consistency, Cronbach's alpha was used which was equal to 0.922.

6. Data Analysis

The statistical data analysis was performed using SPSS version 21.0 (IBM Corp, 2012). Analysis mainly included Leven's test (assessing the homogeneity of variances), paired t-test and independent t-test. In order to analyze the data, the scores were converted to the percentage of correct answers.

7. Results

Among the total of 59 participants, 64.4% were female and 35.6% were male. There was no significant difference regarding the participants' sex between the two groups (P-value = 0.472, $\varphi 2 = 0.517$). 29 and 30 students were allocated to the lecture-first and flipped-first groups respectively. There was no loss to follow up during the study period (response rate= 100%). To present the findings of this study, we firstly compare the results of two teaching methods and then go through the effect of their sequence of delivery.

Firstly, the pre and post- tests mean scores for lecture-based topics were compared between two groups separately. There was no significant difference between the mean scores of lecture based topics between two groups in both the pre-test (P-value = 0.655) and the post-test (P-value = 0.312) (table 1). The same was true when related post-test and pre-test scores were considered as the dependent variable and covariance respectively in the univariate analysis of covariance (ANCOVA) formula (f = 0.921, P-value = 0.341). On the other hand, when the same analysis was performed for the flipped-based topics, there was a significant difference between the mean scores of the students in the pre-test between two groups (P-value = 0.040), though this difference was not observed in the post-test scores of these topics (P-value = 0.094) (table 1). ANCOVA was performed here again for eliminating the pre-test's effect and considering the related post-test scores as the dependent variables and the pre-test scores as covariance, resulted in no significant difference between two groups (f = 0.309, P-value = 0.581).

As table 1 shows the increase of scores from pre to post-tests in all study groups, we assessed the effect of instruction on students' learning and compared the mean scores of pre and post-tests of all participants using Paired T-test (table 2), which showed a significant increase in total mean scores from pre-test to post-test (P-value = 0.001).

In the next step to assess the effect of the sequence of teaching methods, the total scores of the post-test in both studying groups were compared (table 3). Indeed, a significant difference was observed between post-test mean scores in two groups. To explain more, the mean score of the students who started their training with flipped method was significantly higher (P-value = 0.011). Moreover, when we considered post-test mean scores as the dependent variable and pre-test mean scores as covariant in univariate analysis of variance, the significant difference was observed again (F= 12.167, P-value = 0.001).

Finally, the mean score of lecture-based topics was compared with that of flipped-based topics for all students (table 4). The result showed that the mean score of the students in flipped-based topics was significantly higher than the lecture-based ones (P-value = 0.022).

In addition to pre and post-test results, 57 participants completed satisfaction questionnaire (response rate = %96.6). Paired T-test was administered to compare the mean of participants' satisfaction scores of lecture-based and flipped-based topics. Table 5 shows that students' satisfaction of flipped based topics was significantly higher than lecture-based ones (P-value = 0.032). In addition, we examined the difference between satisfaction scores with the two types of teaching between two groups, i.e. lecture-first and flipped-first groups. As shown in table 5, there was no significant difference between the mean satisfaction score of the two methods in the lecture-first group (P-value = 0.312). In contrary, the difference was significant in the flipped-first group showing a higher satisfaction of flipped-based topics (P-value = 0.011).

8. Discussion

In this study, we assigned 59 medical students in emergency medicine rotation in to two groups who were taught eight topics, four in lecture-based and four in flipped-based methods. In fact, the sequence of methods

Topics	Test	Group	No.	Mean*	S.D	T**	Sig.
Lecture-based	Pre-test	First-lecture	29	60.92	19.30	-0.449	0.655
		First-flipped	30	63.18	19.18		
	Post-test	First- lecture	29	61.08	22.10	-1.022	0.312
		First-flipped	30	66.11	15.15		
Flipped-based	Pre-test	First-lecture	29	72.12	21.04	2.108	0.040
		First-flipped	30	61.49	17.17		
	Post-test	First-lecture	29	73.93	16.54	1.705	0.094
		First-flipped	30	66.94	14.92		

*Out of 100, **Independent T-test

Table 1 - Comparing pre-test and post-test results in the study groups.

Groups	No.	Test	Mean*	SD	T**	Sig.
Total	59	pre-test	64.41	15.37	3.528	0.001
		Post-test	71.90	12.78		

* Out of 100, **Paired T-test

Table 2 - Comparing the pre-test and post-test results for all participants.

Group	Test	No.	Mean*	SD	T**	Sig.
Lecture-first	Post-test	29	67.61	12.96	3.528	0.011
Flipped-first		30	75.83	10.98		

* Out of 100, **Independent T-test

Table 3 - Comparing the post-test scores in lecture-first and flipped-first studying group.

Topics	Test	No.	Mean*	SD	T**	Sig.
Lecture-based	Post-test	59	63.63	18.82	2.352	0.022
Flipped-based			70.37	15.99		

* Out of 100, **Independent T-test

Table 4 - Comparing the post-test scores in lecture-based and flipped-based topics in all students.

Group	No.	Topics	Mean*	SD	T**	Sig.
Lecture-first	28	Lecture-based	77.65	14.67	1.030	0.312
		Flipped-based	81.22	13.30		
Flipped-first	29	Lecture-based	80.19	14.94	2.726	0.011
		Flipped-based	85.22	10.57		
Total	57	Lecture-based	78.88	14.57	2.203	0.032
		Flipped-based	83.15	12.03		

*Out 0f 100, **Independent T-test

Table 5 - Comparing participants' satisfaction in total and two study groups.

was different in two groups, i.e. lecture-first and flipped-first groups. Students' learning and satisfaction were assessed in order to understand whether the time of delivering flipped classes during a course matters or not. The results showed that although students' scores have significantly increased in each group separately, the post-test score was significantly higher in the flipped-first group. At the same time, the students of this group were more satisfied with the flipped-based topics in comparison to the other group. Moreover, it was observed that the flipped based topics were more effective regarding students' learning compared to the lecture-based ones.

Reviewing the literature shows different results about the effectiveness of flipped classroom method. On one hand, there are studies that show positive effects on some aspects. In a randomized clinical trial performed by Wazney et al., a positive effect of flipped classes on students' final scores was determined that could be the result of students being able to study more after attending classes considering the availability of e-contents. In addition, it was found that above-average students gained better metacognitive skills through experiencing flipped classes (Wozny, Balser & Ives, 2018). Other evidences that have shown the positive effect of flipped classroom on students' learning are the studies of O'Canner et al. in Radiology course (O'Connor et al., 2016), Boyson–Osber et al. in Advanced Cardiovascular Life Support to physiopathology students (Boysen-Osborn et al., 2016), Koo et al. in a pharmacotherapy course (Koo et al., 2016) and Rose et al. in the medical clerkship rotation in Emergency Medicine course (Rose et al., 2018). On the other hand, there are evidences that have not shown a positive effect for flipped classroom method. For instance, in a cohort study performed at Stanford University by Libert et al. on first year residents of surgery in 2016, there was no clear difference between lecture and flipped classroom method (Liebert, Lin, Mazer, Bereknyei & Lau, 2016). The same findings were observed in some other studies, namely, the study on emergency medicine students in two universities (Heitz, Prusakowski, Willis & Franck, 2015), two studies on ophthalmology clerkship (Tang et al., 2017) and the research performed in a neuroanatomy course (Whillier & Lystad, 2015).

It is worth mentioning that the results of a systematic review conducted in 2017 for assessing "the effectiveness of flipped classrooms in medical education" were largely ambiguous and uncertain. In fact, in most pieces of research done by 2015, the effect of flipped classroom method on the knowledge of medical sciences' students was assessed as the main determinant. Also, most of these studies were performed on pre-clinical medical students or nursing students before clerkship. So. It was concluded that one could not be sure of the possibility of generalization of the results to clerkship or residency students (Chen, Lui, & Martinelli, 2017). Hence, as the results of the present study, which was performed on the Emergency Medicine clerkship students, showed a positive effect of the flipped based compared to the lecture based classes, one could add this evidence to the researches that have proven some positive impacts in this regard.

From another point of view, i.e. the students' satisfaction of flipped classroom method, the present study confirmed that the participants' satisfaction of flipped classes was higher than lecture based ones. This finding is in alliance with a systematic review done by Ramnanan and Pond in 2017 that showed the satisfaction of medical students and residents of different majors from flipped classes (Ramnanan & Pound, 2017). In spite of this evidence, in a randomized interventional research conducted by Wozney et al. in 2018, students were equally satisfied with flipped and lecture methods and stated that studying flipped class' content was time-consuming. At the same time, they were satisfied with interactive classes and problem-solving during the face to face part of flipped classroom method (Wozny et al., 2018).

It is worth mentioning that some studies have assessed factors rather than students' learning and satisfaction. For example, in a study on ophthalmology residents by Tang et al. in 2016, participants stated that flipped classroom method had enhanced their motivation, communication skills and clinical thinking. However, they declared that this method was time-consuming and needed more study-time (Tang et al., 2017). In another study by Ma et al., medical students' motivation, self-regulated learning, and problem-solving ability were found to be significantly higher in medical students who experienced flipped classes compared to lecture ones (Ma et al., 2018).

9. Conclusion and recommendations

In conclusion, these undetermined literature results on the effectiveness of flipped classroom method, poses the need for raising innovative research questions to explore more evidence for its best practice. In this regard, we couldn't find a study which examines the impact of the sequence of delivering lecture based and flipped classes during a course on medical students' learning and satisfaction. So the results of this study would suggest some clues for medical teachers and researchers on the way of using this method within a course instruction. According to the results of this study, it is recommended that flipped classes be applied from the beginning of the course. Although the reason for this preference needs to be investigated, one can raise an assumption that maybe flipped classroom effects rather than cognitive learning, i.e. skills like problem solving, self-regulated learning, clinical thinking and teamwork, would work more when they are enhanced from the beginning of the course. In addition, some students discussed in an informal environment with their professors that participating in flipped classes from the first sessions of the course had made them interested in the topics, so that they had

studied better. Although this is not a high level evidence, it can be a clue for further research on flipped classroom.

This study had some limitations, one of which was the low number of participating medical students who were only from emergency medicine rotation. So, it is suggested that the study be conducted with more participants from different rotations. In our study, due to the quasi-experimental method, we had to take a pre-test to eliminate the effect of the prior knowledge. Although the pre-test questions were designed different to the post-test ones to prevent participants from being sensitive to the questions, it is advisable to select the groups' participants randomly in future studies so that no pre-test is required. In addition, as mentioned before further research is needed to not only confirm the impact of the time of delivering flipped classes during a course, but also the reasons for such precedence.

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