ORIGINAL ARTICLE

THE FLIPPED CLASSROOM MODEL: EXPLORING THE EFFECT ON THE KNOWLEDGE RETENTION OF MEDICAL STUDENTS

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Background: In the Middle East, where most of the higher learning institutions still focus on the teacher-centred approach, implementation of this pedagogical model is an enormous task for educators. This study was designed to assess the role that the flipped classroom modality plays in the knowledge retention of medical students with a background in traditional methods of teaching and learning. **Methods:** This study employed a mixed study design among a sample of 3rd year medical students (n=193) in the neurosciences course block. The students were divided into two groups: experimental and control. A post-test, a questionnaire, and semi-structured interviews as research instruments were used to collect data in this study. **Results:** The results revealed a significant mean difference between the post-test scores in traditional (4.1±0.98) and flipped classroom (3.6±1.03) with a *p*-value=0.01, while no mean difference was found between male and female students (3.9±1.04, 3.9±1.02, *p*-value=0.77). The students appreciated the flipped classroom modality that helped with information sharing, interaction with peers and learning from others' experiences. Correspondingly, the four main characteristics of flipped classroom emerged from the thematic analysis: (1) positive perceptions of the flipped classroom, (2) challenges of the flipped classroom, (3) the effects of personal characteristics, and (4) lack of administration support. **Conclusion:** The performance of students was better in the traditional class than in the flipped classroom, particularly in the cognitive areas that deal with the interpretation and application of knowledge. The students taking responsibility for their own learning in this new modality and the short duration of the study might have had some influence on the study results. Future in-depth studies are recommended.

Keywords: Flipped classroom; Knowledge retention; Mixed-methods study

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INTRODUCTION

There are many instructional strategies that are being used in medical education such as problem-based learning, peer learning, team-based learning, and flipped classrooms or inverted classrooms. A flipped class is one of the blended learning modalities that has gradually developed through the use of various experimentations, with the main focus placed on hybrid problem-based learning. The modality is based on the theory of student-centred learning that emphasizes student engagement in personal development and self-regulated learning processes.[1]

The two major components of a flipped classroom are the transfer of content outside the classroom that is commonly delivered through e-learning and work on assignments in the classroom and homework.[2] In contrast, traditional teaching methods rely only on slides, audio, podcasts, and presentations. The classroom style varies regarding learning expectations, engagement techniques, and levels of self-determination, in addition to other differences. In fact, in flipped or inverted classrooms, the teachers use multiple teaching methods so that students receive information constructively and obtain more benefits.[3]

There are many definitions of a flipped classroom or an inverted classroom but the most applicable one is given by Lage et al, which is that "inverting the classroom means that the events traditionally taking place inside the classroom should now take place outside the classroom and vice versa".[4] As an instructional teaching method, the flipped classroom has many advantages for both teachers and students compared to the traditional classroom. For example, students can learn at their own pace, build concepts with peers, feel less anxiety, receive instant feedback and improve their confidence. In this technique, the teachers work closely with students to improve students' attitude and ability to solve problems.[1]

In the traditional classroom, students attend lectures and then work at home. Less emphasis is placed on interaction among students, attitude building and active participation, whereas in the

inverted classroom, students work with their colleagues on tasks during school hours. The instructor spends more time with the students who require more attention.[5] In medical education, flipping the classroom is considering a building block of curriculum reform. The method enables educators to learn about competency-based education.[6]

A study published in 2016 at Alfaisal University, Saudi Arabia, conducted during the haematology course block, found that the majority of students were satisfied with the flipped classroom and that the students opined that the flipped classroom was helpful in exam preparation and concept building.[7] Another study in 2012 at the School of Pharmacy, Shenandoah University, during the renal pharmacotherapy course block identified improvements in students' academic performance[8], clinical skills, retention of knowledge, and knowledge transfer to healthcare practice and patient care[9].

A flipped classroom can be applied at different stages at the undergraduate level, from basic medical sciences to clinical rotations. At the College of Medicine, KSAU-HS, there have been some reports from different coordinators of the course blocks on the possible negative influence of traditional teaching on the exam scores of the students. Thus, the college has emphasized that faculty members should use the flipped classroom as one of the teaching techniques to improve the students' performance. The program believes that interactive approaches to learning can influence students' learning and performance. However, in order to assess the efficacy of the flipped instructed studying strategy in undergraduate medical classes, it is imperative to carry out research on the influence or effectiveness of flipped instruction. More research is needed to determine whether the flipped learning method may improve learners' neurosciences knowledge, as well as to determine the attitude and challenges of the students concerning teaching instruction under flipped instruction. In order to fill in these research gaps, the current research paper assess the effectiveness of the flipped classroom as a teaching method in the neurosciences course block and its effect on knowledge retention. This research will provide information regarding the effectiveness of the technique and the possible factors that may have an impact on the outcome.

MATERIAL AND METHODS

This mixed-methods study that was conducted at the College of Medicine, King Saud Bin Abdulaziz University for Health Sciences (KSAU-HS), Jeddah, Saudi Arabia, included all third-year medical students: 119 male students and 74 female students. In the bachelor's degree programme in medicine at KSAU-HS, Saudi Arabia, flipped learning techniques have been applied since 2016, along with PBL in certain course blocks. Many sessions have been conducted to introduce this approach to all students from the 1st year to the final year before formally making the technique a part of the medical curriculum.

This study employed a two-group post-test only experimental design for the quantitative part, where the students were divided into two groups (experimental and control) to test for the effect of the flipped classroom modality and the perceived impact on the retention of knowledge. Correspondingly, an open invitation was sent to students to participate in any of the two modalities during their neurosciences course block. The 3rd year students were chosen for convenience and accessibility, since students at this level are more mature in terms of problem-solving skills and are easy to access and available for follow up.

The sample size was calculated by using the 'Piface' software program, using the power of study as 80, with α=0.05. With a mean difference of 0.5 and a standard deviation of 1, the estimated sample was 51 male students and 35 female students in each group. Those students refused to participate or did not appear in the post-test were excluded. Although the sample size was small, the current study is meant to serve as a pilot study, on which larger-scale studies could be based.

In the current study, we used an electronic course management system called Blackboard which allows faculty members to provide course-related content to students, communicate with students quickly, and provide feedback and grades in an electronic format. The students were given access to content, related reading material, presentation, and videos that were posted on Blackboard before the class. The reading materials and videos were adapted from the existing videos on different websites. Students were allowed to watch the videos as many times as they wanted. In addition, the students were required to respond to questions prior to class or to participate in group discussions on Blackboard.

The researchers designed five objectives under six classes so that the knowledge retention of the students could be improved. The content of flipped class was prepared by experts and reviewed by the curriculum committee to check the quality and accuracy of the material. The students of this study attended flipped classes two times a week, and the duration of the class hour was 60 minutes, as designated by the university. In the flipped classroom, the class time was dedicated to more interactive discussions, small group work, tutorials,

or writing reflection aimed at reinforcing and/or clarifying the main points covered in the videos and learning materials that were sent to the students prior to the session. The teacher used the first session to introduce topics, course materials, and the concept of flipped learning and the last session for course evaluation, filling up the questionnaire and conducting interviews. Students were expected to participate fully in class activities including group and individual activities, presentation, group discussion, and answering the questions followed by the conclusion of the session. There was no interaction among the students in the traditional lectures, and the students were allowed to ask questions when time permitted.

The knowledge was assessed by using the post-test. The post-test was conducted after the implementation of the lecture and flipped class modality for both groups. The post-test consisted of 05 MCQs on C1 (recall of information) and 05 MCQs on C2 levels (interpretation and application of data) that were based on the course block theme, and the specific learning objectives for epilepsy were prepared and conducted in the students' respective classes by one of the researchers. There was no MCQ to evaluate the knowledge domain of problem-solving (C3). The cognitive levels of the assessment tools were analysed using Buckwalter's method[10] and a revised version of Bloom's taxonomy[11]. The questions were prepared by two subject experts who were selected by the head of the assessment unit of the college to ensure the confidentiality of the examination. The MCQs were stored on a password-protected computer.

Additionally, a structured, self-administered questionnaire, with a five-point Likert scale from strongly agree to strongly disagree, was used to assess the students' perception of learning and engagement in the interactive flipped classroom method (see appendix). The researchers forwarded the questionnaire to two faculty members who had the backgrounds of teaching both traditional and flipped class to check its content validity. The experts' feedback on the questionnaires' content confirmed that the items were appropriate for measuring the study's objectives. The questionnaire was piloted to the students who did not appear in the post-test (n=08) before being administered to collect the data to ensure its reliability. The Cronbach alpha coefficient was conducted to determine the questionnaire's reliability, and the value was r =.81.

After ethical approval from the university research committee, permission from the academic affairs department was also obtained to schedule sessions with third-year students. Participation was voluntary, and no incentives were offered. To protect the students' rights, the identities of the students remained anonymous.

In the qualitative part of the study, to determine the perception and associated challenges of this new method of learning, six face-to-face semi-structured interviews were conducted (N=6). Researchers interviewed those students who consented to participate. An interview guide was prepared (see appendix). The interviews were conducted two weeks after the flipped classroom. The interview allowed the students to express their experience in their native language. All interviews were recorded using an audio-recording device and lasted from 20-30 minutes. The interviews were transcribed, and the themes were generated by two independent transcribers to avoid any inaccuracies in the transcriptions.

Data were entered and analysed using SPSS version 20.0. For the descriptive statistics, the mean and standard deviation were estimated for quantitative variables such as the score on the post-test. For inferential statistics, an independent t-test was used to compare the means of the different groups. A p-value of <0.05 was considered to show a statistically significant difference.

For analysing the qualitative data, we used a thematic analysis to highlight the commonalities and patterns in the students' responses regarding their personal experience by coding and categorizing the themes. Phrases as well as keywords mentioned by the students in the interview were used to identify these themes.

RESULTS

The demographic distribution of the third-year graduate students is shown in table-1. There were 72 (55%) male medical students and 60 (45%) female students. Among the 75 students who participated in the lecture-based teaching, 57 students were enrolled in the flipped classroom (Table-1).

The post-test examination scores of the students were analysed. The results show a significant mean difference between the traditional classroom (4.1±0.98) and the flipped classroom (3.6±1.03), with p-value = 0.01 (Table-2).

We also compared the mean difference between the scores of the male and female students and found a statistically insignificant mean difference between the male students (3.9±1.04) and female students (3.9±1.02), with p-value = 0.77 (Table-3).

A validated perception survey was distributed at the end of the flipped classroom (Table-4). Out of the 59 students who participated in the flipped classroom, 50 students (the response rate was 85%) filled out the questionnaire. Among these students, 24 (48%) were male and 26 (52%) were female (Table 4). The majority of the students from the experimental group [n- =37, 74%] opined that the flipped classroom helped them better understand the course block content and that it stimulated their ability to think independently (82%). Seventy-eight percent of the students appreciated the flipped classroom's effective role in the retention of course material. Sharing of information and communication with the peer group (88%) was another area that was highly regarded by the experimental group (See Table 4).

Furthermore, a thematic analysis was chosen to highlight the main patterns that arose from the students' experience. The themes and sub-themes derived are shown in Table-5.

It became obvious that the flipped classroom method helped not only with recalling the factual information, pre-reading the material, and the communicating and sharing of information with the students' colleagues but also with improving the students' self-regulation of learning, self-confidence, and their understanding of the material and evaluation role.

> *"I got better scores because I came prepared before a session and I had to, because in this method, the student should depend on himself and should be more responsible for learning on his own. In this way of teaching, the student gets the chance to choose the sources of information and can get information in various ways (audio or visual or written, etc.*" (P2, P6)

All the students confirmed that the flipped classroom improved their communication skills and ability to share and receive information from other students in a constructive way.

> "*In the flipped classroom, the emphasis on an interactive approach enhanced my communication skills and I feel that they are much better.*" (P3)
>
> "*All the students tried to share authentic information and more factual information, which prompted healthy and effective communication among the classmates.*" (P6)

Various challenges that were faced by the students were identified. These included the time-consuming nature of the flipped classroom, lack of confidence in deciding on the material, depression upon failure, the minimal role of faculty members, lack of faculty support, lack of resources (internet), few training sessions and lack of consistency of information.

> "*…conducting the flipped classroom needs to be supported by the academic affairs department at the college and the faculty members, who should provide the learning material earlier so that the students can read it and prepare for the session.*" (P3, P5, P6)
>
> *"....it needs more resources, for example, the internet and laptops...*" (P4)
>
> "*…so, I will be more confident, and I will be able to understand the topics and the objectives or the explanations by the teacher."* (P3, P5, P6)

Other personal factors were also pointed out that hindered the learning process. These factors included the shy nature of the students, lack of confidence, domination by some students, and the lack of trained faculty or student training.

> "*…so, I cannot perform well due to my shy nature and lack of confidence, and it is imperative in a flipped class to be able to understand the topics and the objectives or the explanation by the teacher."* (P3, P5, P6)

A few students did not find an active role of the academic affairs department in this teaching modality.

> "*…so, I cannot see any active involvement of academic affairs department. In my opinion their role is very important for the success of this strategy"* (P2, P4)

Table-1: Demographic Data(N=132)

	Gender	n	%
Traditional class	Male	41	55
	Female	34	45
	Total	75	100
Flipped class	Male	31	54
	Female	26	46
	Total	57	100

Table-2: Mean post-test scores for Taditional class and Flipped classroom

Group Stats	n	Mean±Std. Dev	*p*-value
Traditional class	75	4.1±0.98	0.01
Flipped class	57	3.6±1.03	

Table-3: Mean post-test scores for male and female students

Gender	n	Mean± Std. Dev	*p*-value
Male	72	3.9±1.04	0.77
Female	60	3.9±1.02	

Table-4: Students perception regarding the Flippedclassroom (N=50)

Students' Perceptions (N=50)	Strongly disagree/Disagree	Strongly agree/Agree
1-Flipped classroom increased my knowledge and of block material.	13	37
2-Flipped classroom improved retention of course material.	11	39
3-Flipped classroom provided opportunity to share information with classmates.	06	44
4-Flipped classroom stimulated me to learn and think independently.	09	41
5-Flipped classroom is a time consuming technique.	11	39
6-Flipped classroom helped me to communicate with classmates.	06	44
7-I am satisfied with flipped classroom techniques.	17	33

Table-5: Thematic analysis of students responses through semistructured interview

Themes			
Theme1	**Theme 2**	**Theme 3**	**Theme 4**
Perception about FC	**Challenges of FC**	**Effect of personal characteristics**	**No administrators support**
Easy to recall of factual information Pre-reading material Inculcate self-regulatory learning Communication and sharing of information Help in Confidence building More effective in understanding of material Play an evaluative role	Time consuming Lack of confidence to decide the material Depression on failure Minimal role of faculty Last minute sharing of materials	Shy nature of student Lack of confidence Domination of one student Lack of trained faculty Lack of consistency of information Best for postgraduates	No active role of academic affairs dept. Lack of guidance from academic affairs

DISCUSSION

This study was designed to assess the effectiveness of a traditional class versus flipped classroom in the neurosciences course block that is offered to third-year undergraduate medical students. Our study did not support what has previously been reported in the literature regarding the positive impact of the flipped classroom on the students' performance. We found a positive effect of the traditional class on the overall performance of the students, particularly regarding the interpretation and application of data. The results are similar to the study conducted by Hani et al. on the effectiveness of a flipped classroom and its impact on learning styles of dental students; Hani *et al*. found no significant difference in students' performance[13] between a pre-test and a post-test[14] Moreover, another study conducted by Jamie L *et al* showed no difference in students' performance between low-level and high-level items (*p*-value=66).[15] This contradictory result from the post-test and the students' opinions suggest the importance of training and more time for preparation to understand the learning objectives and planning. Other reasons for this result can be the lack of students' motivation to adopt this new method of learning, which requires self-effort.

On the other hand, researchers found that the students' performance in the flipped course showed significantly higher scores on the respiratory and cardiovascular sections and that the examination averages for students in the flipped course was higher for the renal course.[16] The authors believe that flipping courses may provide an alternative method to teaching that improves active learning specifically in the fields of public health, applied, and health management programs[17] and is better in achieving the identified learning objectives than the conventional educational teaching[18,19], though the flipped classroom was reconsidered for many reasons[20].

Furthermore, our results from the survey and thematic analysis confirm the overall satisfaction of the male and female medical students. Although, the results of the survey and the qualitative analysis of present study showed the students' positive attitude towards a flipped classroom in terms of sharing of information and communication among peer groups, a lot of students similar to those in the present study had reported challenges, including lack of enough time to understand some topics and finish their work, the passive learning style and the resistance of students to adopting a new model[20], the lack of training for both students and faculty members, the very busy schedule of the students[12], lack of motivation, or highly complex content[14], and lack of a genuine interest in the learning objectives[21].

The findings of this study are unique, as they provide information about the direct association of traditional versus flipped classroom methods in which the students were exposed to the same tutors, course content, instructional method, and assessment. Such type of a comparative study among medical students has not been done before, to the best of the authors' knowledge.

Nevertheless, perceptions vary from person to person, as identified in the individual interviews with the students from the experimental group, the flipped classroom focuses on the active participation of both students and instructors and on pre-class preparation; thus, the flipped classroom allows classroom time to be focused on problems or discussions, which involve more active learning. The availability of online access at the KSAU-HS offered

students the opportunity to investigate the utility of flipping, and we envisioned the pre-class preparation as watching videos or reading some articles. There are some studies that have reported impediments with this method. For example, Jacob Enfield from California State University, Northridge, found some resistance while conducting the flipped classroom. Some of the students believed that it is the teacher's responsibility to provide the resources and not the students' responsibility, especially because they paid for the structured education. The majority of the students (94.6%) believed that the use of videos to obtain information was truly challenging for them[22], and so they came to class unprepared[23]. The results are more or less similar to those reported by our study.

The main limitation of this study is the sample technique, which took the sample from only one institution. Nevertheless, because of the small number of participants, the results are limited in their generalizability. Another limitation of this study is that the flipped classroom approach was applied only to one course block, thus limiting the impact and scope of this study. We were thus unable to identify which specific component of the course in the flipped classroom would be most beneficial for students. Our study did not look at the effect on long-term memory to evaluate the effectiveness of the flipped classroom format. Furthermore, introducing a flipped classroom into the curriculum requires more training for faculty members and students.

CONCLUSION

In summary, the student perceptions of the flipped classroom were somewhat diverse but were generally positive. The students tended to prefer the traditional lectures more than the flipped classroom. This mixed study shows the students' preference for the traditional approach. However, both the flipped classroom format as well as the traditional teaching format worked well in the delivery of a unit of undergraduate neuroscience courses. Future research could focus on the way that the flipped classroom is delivered: such as, resources could be provided to the students at the start of the course block, and the long theoretical lectures could be transformed into short lectures, thus enhancing the students' preparation and interaction. Longitudinal and multi-centred studies should be conducted to assess the flipped class modality in learning and teaching.

Conflict of Interest

There is no conflict of interest.

Acknowledgements

Not applicable

Ethics approval and consent to participate

The study protocol was approved by the King Abdullah International Medical Research Center (KAIMRC) at the National Guard in Jeddah (Ref. no. SP17/270/J). Participation was voluntary, and the researchers obtained written consent from the participants before their participation in the study.

Consent for publication

Not applicable

Availability of data and material

The data sets used and/or analysed during this study are available from the corresponding author upon request.

Competing interests

The authors declare that they have no competing interests.

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AUTHORS' CONTRIBUTION

MA: Designed the conceptual basis for the study, developed the manuscript, and finalized the study. SA: Contributed the qualitative data analysis, write-up and revision of the manuscript. MAK: Contributed to the data analysis and the interpretation and revision of the manuscript. MA: Supervised the study and edited the manuscript.

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