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Effectiveness of flipped classroom model in teaching histology for first-year MBBS students based on competency-based blended learning: An interventional study

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Abstract:

BACKGROUND: With recent changes in the curriculum of bachelor of medicine and bachelor of surgery (MBBS) course to meet the global trends and to fulfill the standards expected from an Indian medical graduate, introduction of newer teaching methodologies becomes mandatory. The usage of flipped classroom (FCR) in medical education has always been rewarding. This study was to evaluate the effectiveness of FCR as a teaching method in comparison with traditional lectures in histology sessions in Sri Ramaswamy Memorial (SRM) Medical College Hospital and Research Centre, Chennai, Tamil Nadu, India.

MATERIALS AND METHODS: This interventional study was conducted among the 1st year MBBS students in SRM Medical College Hospital and Research Centre for a period of 1 year (2018–2019 academic year). The histology sessions were taught using both traditional lectures and FCR methodology. Pre- and posttests were conducted for each traditional and FCR session with ten multiple-choice questions pertaining to that topic. Students' performance was assessed by paired *t*-test (for pre- and posttest comparisons) and independent *t*-test (for traditional and FCR posttest mark comparison) using SPSS software version 26. A feedback survey based on Likert scale was also conducted on the students and was analyzed. $P < 0.05$ was considered statistically significant.

RESULTS: Posttest marks had statistically significantly improved when compared to pretest marks ($P < 0.0001$) in both traditional and FCR teaching methods. Comparison of posttest marks showed statistically significantly higher marks in FCR when compared to traditional teaching ($P < 0.0001$). Similarly, students' feedback survey showed that FCR benefitted the students in achieving the competency required.

CONCLUSION: FCR methodology of teaching histology had a very impressive outcome and the students' perception was very positive.

Keywords:

Feedback, flipped classroom, histology, students' perception, traditional class

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Introduction

Bloom's revised taxonomy describes that in traditional methodology of lecture sessions, the students are doing their lower level of cognitive work of gaining only the knowledge component.[1] As anatomy forms the foundation of MBBS course, with the growth in curriculum requirement, focusing on higher forms of cognitive work such as application, analyses, synthesis, and evaluation is of paramount importance for a better understanding of clinical content with basic sciences. This forms the mainstream in

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the reevaluation of delivering lectures in the classroom itself.

The flipped classroom (FCR) approach involves two major components.[2] The first component involves delivering the lecture outside the classroom in the form of giving preread materials, which can be of any format using electronic means. The format can be varied from a slide presentation, audio podcasts, videocasts, animations, screen captions, and evidence-based website links. The second component of flipping the classroom includes problem-based learning (PBL) and discussions, which reaches the next level of learning outcomes about the assessment of clinical competence.[3] This leads to the application of knowledge, resulting in comprehensive thinking. This can be achieved by more active learning opportunities for students in small groups, which increases one-to-one interaction between the student and the teacher.[4] This also facilitates the concept of self-directed learning, where students become more responsible than the facilitator.

In the flipped class, the students will be in more active mode by spending most of the time in the practical application of the knowledge they gain. The core competence can be divided into various subcompetencies, a technique called "chunking," which makes the students to have a easier way of interconnecting the contents, correlating the basic knowledge acquired, for better clinical understanding and critical thinking.[2]

The microscopic study of anatomy is histology, which is a part of first-year MBBS curriculum that involves studying the tissues and organs under microscopy by staining the tissue using basic stains such as eosin and hematoxylin and various other special stains. The knowledge of histology is crucial for a better understanding of the concept of histopathology, for a more accurate diagnosis of various diseases including carcinoma.

Educational strategies for learning basic medical sciences have shown tremendous growth in recent years from traditional microscopy to virtual microscopy. In addition, for better clinical correlation with histopathology, the teaching methodology adopted has been modified to PBL, interdisciplinary integration in alignment with preclinical, paraclinical, and clinical subjects.[5,6]

To meet the global standards and to fulfill the role of an Indian medical graduate to meet or exceed the global benchmark on knowledge, attitude, skills, and communication, the revised undergraduate medical curriculum has been structured. Hence, to fulfill all these competencies, the teaching–learning methodology should be further evaluated. Hence, FCR methodology can be an alternate model that facilitates student-centered learning and increases comprehensive thinking, by learning the subject at the individual's pace and time. In this study, FCR approach has been applied in the histology curriculum and the influence of this approach was quantitatively and qualitatively compared with the conventional didactic lecture teaching to further the existing knowledge of the efficacy of this approach.

Materials and Methods

MBBS curriculum in India is for 5½ years including the house surgeon period. The Medical Council of India has now revised the curriculum for MBBS, and the first phase includes 13 months. The department of anatomy has a total duration of 675 h including 220 h of lecture sessions. The course content includes gross anatomy, histology, and embryology sessions. Histology is covered throughout the semester for 10 months that covers around forty sessions. The course material is further divided into general histology and systemic histology. The course is evaluated by both formative and summative assessment methods as internal assessments and university examinations. In this study, universal sampling method was used and 150 students of the 1st-year MBBS batch were enrolled. All the students were priorly informed about the purpose of the study and consent was obtained.

Study design

Out of the forty histology classes, the first twenty histology lectures, which include general histology and respiratory system, were taught in traditional didactic lectures. The remaining twenty systemic histology classes were done in the FCR model. The study was approved by the institutional ethics committee (1431/IEC/H/2018). The students involved in the study had no prior specialization in the knowledge of histology both in general and systemic components. This ensured that the difficulty level of both groups at the beginning was the same. In the present study, FCR was conducted by preparing preread materials well in advance and delivering to the students through group E-mails and students' WhatsApp group for the batch 2018–2019. The preread materials include brief introduction about the topic in the form of PowerPoint presentation, recorded videos, and web links related to the topic of each individual class, which were delivered to the students well in advance, 4–5 days before the specific class, so that they could learn the introductory materials beforehand.

Figure 1 shows the overall study design of the present study.

In-class activity for FCR includes a problem-based case followed by small group discussions with active interaction of students. The 150 students were divided into 15 small groups of 10 students each. Five facilitators

were allotted to each of the three groups to monitor students' activity. Before the start of the session, pretest was conducted in the form of ten multiple-choice questions (MCQs) for each session in Google Forms to assess the knowledge, comprehension, and cognition components of Bloom's taxonomy and how well the prereads were utilized. At the end of the session, a posttest was also conducted in Google Forms with the same ten MCQs. Similarly, for the traditional didactic lecture method, pre- and posttests were conducted using ten MCQs. All the MCQs used in this study were selected from the question bank repository in the department, which includes MCQs from previous years' question papers, which were item analyzed and segregated based on difficulty level and discrimination index. MCQs with difficulty level between 30% and 70% and items with a correlation of 0.20 or higher were considered for discrimination index to maintain identical difficulty and discriminatory levels in MCQs in both teaching methods.

The students were also requested to fill anonymous and voluntary feedback surveys based on a 5-point Likert scale. The scale starts with the lowest remark of strongly agree to the highest rank of strongly disagree. A separate column was also provided for adding up any additional remarks. A validated questionnaire used in a previous similar study was adopted with slight modification.[7] The academic board members of the department, who were familiar with the study population, analyzed the questionnaire to check if the items of the questionnaire were relevant to the study and to check for any practical difficulties. They also evaluated the appropriateness of the content of the questionnaire. These steps were done as a way of revalidating the questionnaire. The internal consistency of the questionnaire was calculated using Cronbach's alpha test for reliability. The reliability coefficient for all the ten items of the feedback questionnaire was found to be 0.77. This is indicative that the questions in the feedback survey form and the results obtained from them are highly reliable and consistent. Students' response was also included in the qualitative analysis of this study. The total scores obtained from pre- and posttests of both teaching methodologies and the posttests of both the FCR and traditional didactic lecture methodologies were used to analyze the effectiveness of intervention.

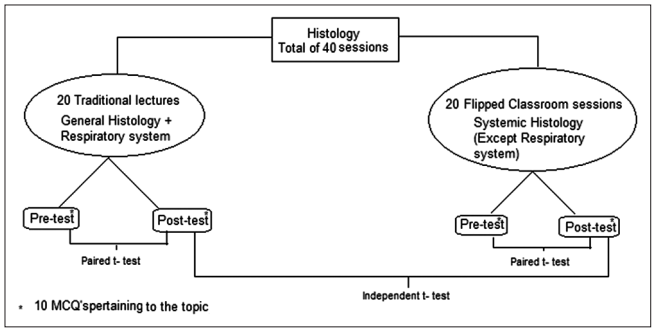

Figure 1: Consort diagram of the study

Statistical analysis

The data were coded and entered in Microsoft excel (MS office 365). All the statistical analyses were performed using SPSS version 26.0 (IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY). Comparison of pre- and posttest marks of FCR and traditional lecture methods was done using paired *t*-test. Comparison of mean posttest marks between the two teaching methods was performed using independent *t*-test. Mean and standard deviation (SD) were calculated for the responses of the 5-point Likert scale as a part of feedback analysis of FCR intervention obtained. $P \leq 0.05$ was considered statistically significant.

Results

Comparison of pre- and posttest marks of FCR and traditional lecture methods using paired *t*-test is shown in Table 1. There were statistically significant improvements in the mean marks in posttests compared to pretests in both the teaching methodologies ($P < 0.0001$). However, the mean posttest marks were higher in FCR method.

To further elucidate the effectiveness of FCR method when compared to traditional lectures, the posttest marks of both the methods were compared using independent *t*-test. There was a statistically significant difference between the mean test scores of both the methods. The mean and SD were 4.122 ± 0.06 and 6.686 ± 0.05 for traditional lecture and FCR methods, respectively ($P < 0.0001$; $t = 30.32$; df = 38). This clearly shows that FCR provides significant improvements in students' test scores when compared to the conventional lecturing method of teaching histology [Figure 2].

Feedback analysis

Table 2 shows the responses to the feedback questionnaire based on the Likert scale. On an average, about 57% and 33% of the students either strongly agreed or agreed positively on the feedback questionnaire about the implementation of FCR methodology for teaching histology.

The responses to all the ten questions had a mean value ranging between 1.3 and 1.8, showing that the students

Table 1: Comparison of pre- and post-test marks of flipped classroom and traditional lecture

Teaching method	Mean±SD			*t*, df
	Pretest mark	Posttest mark	Mean difference	
FCR	4.28±0.44	6.69±0.26	−2.41±0.42****	−25.56, 19
Traditional lecture	2.53±0.29	4.12±0.28	−1.59±0.37****	−18.87, 19

****$P<0.0001$. SD=Standard deviation, FCR=Flipped classroom

Table 2: Percentage distribution of feedback response for questionnaire across Likert scale and the average response for each question

Item number	Questions	Response					Mean±SD of Likert response
		Strongly agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly disagreed (%)	
1	FCR is a new concept in learning histology	72	26.00	2.00	0.00	0.00	1.30±0.50
2	Understanding the content/concepts with flipped class teaching is much better	61.33	34.00	4.67	0.00	0.00	1.43±0.58
3	Do you prefer FCR over traditional instruction and homework	49.33	32.67	16.67	1.33	0.00	1.70±0.79
4	FCR provides a learning environment and a session for discussion	66.00	29.33	4.00	0.67	0.00	1.39±0.6
5	Preread materials provided were very useful	58.00	34.00	7.33	0.67	0.00	1.50±0.66
6	This teaching methodology makes me more confident about facing exams	45.33	34.67	18.67	1.33	0.00	1.76±.80
7	FCR teaching helps to remember the key information better than the traditional method	60.67	33.33	6.00	0.00	0.00	1.45±0.60
8	The prereads provide more autonomy for students than to depend on the facilitator	39.33	43.33	16.00	1.33	0.00	1.79±0.75
9	The teaching methodology provokes interest in learning and working as a group	50.67	32.67	13.33	2.67	0.67	1.70±0.85
10	More similar sessions are appreciated in future	63.33	29.33	6.67	0.67	0.00	1.44±0.65
	Average	56.60	32.93	9.53	0.87	0.67	

Strongly agree=1, Agree=2, Neutral=3, Disagree=4, Strongly disagree=5. SD=Standard deviation, FCR=Flipped classroom

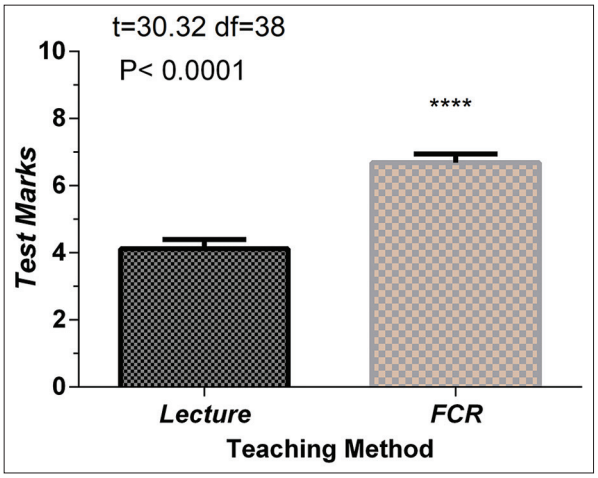

Figure 2: Mean and standard deviation of test scores between traditional lecture and flipped classroom sessions by independent *t*-test. ****P<0.0001

either strongly agreed or agreed to the items in the questionnaire. Only 1.54% (disagree – 0.87%, strongly disagree – 0.67%) of the study population responded negatively about the implementation of FCR for teaching histology.

Discussion

Through the years, FCR was denoted by various other terminologies such as "the inverted classroom, reverse classroom, or backward classroom."[8] Veronese *et al*. used a similar technique called peer instructions and concept tests to enhance PBL.[9] Unlike traditional lectures, the FCR utilizes technology where the students can revise the lessons and can elaborate their knowledge further. The student-centered approach employed in FCR fosters the development of lifelong learning skills.[10] FCR utilizes active learning, engaging students in two aspects, namely, doing things and thinking about the things they are doing.[11]

In this study, the overall students' performance was higher in FCR when compared with that of traditional lecture sessions, which reflects the influence of the two teaching methodologies. Similar research by Jinan University based on the FCR for histology course concluded that FCR played an important role in the success of their students.[12] Tune *et al*. compared the effectiveness of a traditional lecture with modified FCR for cardiovascular, respiratory, and renal physiology for 1st-year medical students at Indiana University and found the latter to be effective comparatively.[13] Based on Kolb's four styles of learning, it was found that flipped histology sessions were more effective than the traditional method.[14]

Previous studies on the influence and satisfaction on the use of FCR were quite promising. In our study, students found FCR to be friendly and reported that they were able to understand the basic concepts involved in histology and that FCR promotes team-based learning. Students also reported that they prefer more FCR-based anatomical teaching sessions in future, thus giving anatomy educators more options in teaching methods that are different from the routine didactic lecturing sessions. Similar to our study, the use of FCR in various disciplines and students' perceptions about this approach have been reported to be having a beneficial effect among students.[9-11]

The way of delivering the FCR differs depending on various factors such as the number of participants, the discipline, the technology, and resources used. The teaching style of the faculty has the greatest impact on the effective implementation of FCR. With a large number of students, additional teaching assistances would only benefit the effectiveness. A survey conducted among faculties for FCR trends showed that around 70% of the faculties have tried applying the FCR in their classes and a majority had a positive experience in flipping the classes.[15]

In this study, we adopted a method called concept mapping as an in-class activity to achieve higher levels in Bloom's taxonomy. The process was achieved by demonstrating a graphical representation of a similar tissue system and comparing the similarities and dissimilarities between them. Based on Ausubel's assimilation theory of learning,[16] this concept mapping can be used as an adjunct tool for teaching histopathology. It invariably enhances problem-solving skills and improves critical thinking to a variable extent. The benefits of histology classes relate more to the identification of the specific slides. The use of concept maps provides a desirable outcome, which helps the students to retain the key elements for proper identification/diagnosis of the tissue. FCR studies are not only pertained to 1st-year medical studies but also carried forward in teaching pathology section.

Literature has also analyzed the negative impacts of FCR models. The results revealed that working or the study time for the students outside the class was comparatively less. The students resist learning topics on their own.[6] Angadi *et al*. revealed that students' scores have shown effective improvement, however students found the new approach to be overwhelming and intimidating.[4] Self-motivation of the students also plays an important role in reading the preclass materials.

The negative impact of FCR can be overcome by identifying the students' readiness level for eLearning and increasing their motivation. Moreover, the small groups created within the students make them more active and provide an opportunity for an one-on-one interaction within the group. This way, peer pressure becomes indirectly beneficial in improving the necessity of learning before the class.

Conclusion

Our study demonstrates a successful implementation of FCR methodology in undergraduate medical students for teaching histology, based on both improvement in students' performance and positive feedback. Adaptation of newer teaching methodology is necessary to meet the new curricular reforms and demands by the Medical Council of India. We strongly believe that our study would help the academicians to remodel their teaching methods by providing valuable insights. The present study is limited to assess the effectiveness of FCR methodology for histology sessions alone in 1st-year MBBS students. Future studies are needed to implement the same in other subjects of the MBBS curriculum.

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Conflicts of interest

There are no conflicts of interest.

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