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Original Research Article

FLIPPED HISTOLOGY CLASSES – ASCENDING BLOOM'S TAXONOMY TO ACHIEVE EFFECTIVE LEARNING: A PILOT FEASIBILITY STUDY

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ABSTRACT

Introduction: Learning histology often pose a unique challenge to first year students. It has a central visual component by which students have to analyse and interpret the micrographic images. Development of an active learning strategy where students understand the rationale of what they learn and apply the newly gained knowledge to specific problems. Flipping the class allows the students to go over the lower levels of learning in Bloom's taxonomy (knowledge and understanding) individually. The aim of the present pilot initiative was to assess the effectiveness of flipped classroom teaching in improving students' learning outcomes.

Methodology: In the present study, a pilot histology curriculum of three systems was implemented among 150 first year medical students in a flipped classroom format at our institute. We developed a learner-centred instructional design model and applied strategies reflecting Kolb's four styles of learning. A questionnaire was administered to document the perceptions of students.

Results: 45% of students agreed and 41% students strongly agreed that the sessions were useful in learning histology in a better way; Majority of students agreed that the sessions were useful in understanding the topic as a whole. 98% students felt that flipped histology teaching method was more effective than the traditional method for improving their knowledge on histology and found the sessions interesting and more engaging.

Discussion: This pilot study suggests that flipped classroom approach can be used to improve histology education among first year medical students. We hope that by applying the principles of adult learning and learner-centred instructional design to design laboratory sessions could help us in developing self-directed learners. However, further concrete studies are required before reliably implementing our format as a teaching modality.

KEY WORDS: Histology, medical education, anatomy education, flipped classroom, Bloom's taxonomy.

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INTRODUCTION

The setting of large lecture classes often offers a big challenge for the instructor, as it seldom provides chance for actively engaging the students in classroom activities. On one hand, developing a concept from its root level and re-inforcing it using suitable examples exhausts the entire time available and on other hand, it denies the opportunity for the students to learn at their own pace. In contrast to traditional lecture classes where the teacher stands in front of the students and students remain as passive recipients of disseminated knowledge, flipping helps in fostering higher order thinking skills.

Constructivist theory of learning states that learning is the process of constructing new knowledge from what students already know [1]. It has been proposed that a learner undergoes five stages in the learning experience and the responsibilities of the teacher varies according to each stage [2]. In the first phase, the learner's existing knowledge is challenged, followed by a second phase where the learner finds out explanation for the pertinent problem and this leads to generation of newer concepts which later gets organized. The organized knowledge is tested by application and then reinforced in a better way [2].

Bloom's Taxonomy categorizes students' cognitive activities into six hierarchical levels ranging from basic recall to application / synthesis [3]. Flipping the class allows the students to go over the lower levels of learning in Bloom's taxonomy (knowledge and understanding) individually. Face to face class time can be used as a potential learning environment to hone higher levels of learning such as critical thinking and problem solving. Anatomy, being a knowledge based competency, is taught and tested at lower levels of Bloom's taxonomy (recall type of questions).

Learning histology often pose a unique challenge to first year students. It has a central visual component by which students have to analyse and interpret the micrographic images [4, 5]. Students need to visualise the two dimensional microscopic images and reconstitute it into three dimensional structures. In our previous study [6], 82(67.2%) students were not able to get the three dimensional orientation from focused slides. This makes the students adopt a superficial learning, involving mere visual memorization of microscopic images. This deprives the students from understanding the functionality of specific tissues or organs which forms the central tenet for understanding histology [7].

This demands development of an active learning strategy where students understand the rationale of what they learn and apply the newly gained knowledge to specific problems [8]. In addition, the present generation students, being accustomed to electronic devices and multimedia learning, find conventional didactic lectures less interesting [9,10].

This is particularly pertinent in histology where students get bored and disgruntled to passively memorize the appearance of microscopic structures [10]. Flipped classroom, by virtue of its asynchronous learning activities promulgate more flexible and deeper learning experience [11]. In addition, it provides chance for effective utilization of face to face classroom timings [11] by reaching the higher level of cognitive activities according to Bloom's taxonomy. The aim of the present pilot initiative was to assess the effectiveness of flipped classroom teaching in improving student's learning outcomes.

MATERIALS AND METHODS

Based on our previous work [6] and recommendations provided by a study [12], we identified the potential limitations in the existing teaching methodology. The objectives for our flipped histology classes included: a) using outcome oriented focussed learning approach b) developing a precise plan keeping in mind the educational principles and available resources c) make the students utilise the reading material in person and applying it in common d) adequately preparing for taking part in laboratory sessions e) climbing the Bloom's taxonomy (illustrated in Fig 1). We bore in mind that students when provided with a variety of learning strategies in combination with higher-level understanding and visualization usually do well in acquiring anatomical / histological knowledge [13].

Fig. 1: Components of Bloom's taxonomy covered in flipped histology class.

The conventional histology curriculum consists of weekly theoretical sessions (one hour duration) and laboratory practical sessions (two hour

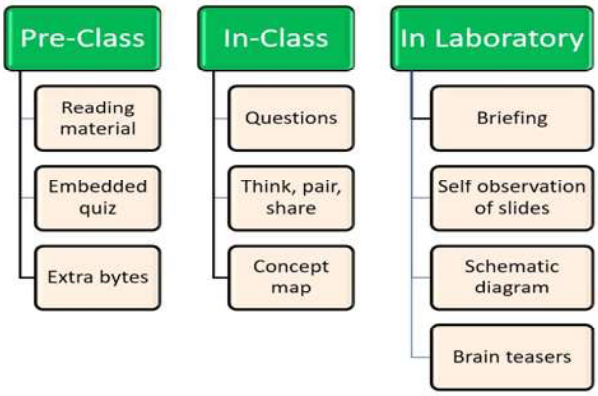
duration). This pilot initiative was administered in three topics (lymphatic system, salivary glands and skin) and all 150 students were requested to involve in this. The topics were selected after ensuring the implied clinical importance. The flipped class protocol (illustrated in Fig. 2) included:

1. Providing a pre-class reading material, a self-explanatory PowerPoint presentation 5-7 days prior to the class. It focused on the specific learning objectives with embedded exercises (preparation phase). The material was circulated through social media(WhatsApp) and e-learning platform. Instructions regarding the design of initiative and role of students were explained in tandem with the learning material

2. In-class events were arranged in an order to stimulate student's interest and learning. The presentation already circulated was not repeated during the session. Questions, ranging from the lowest strata of Bloom's taxonomy to the highest strata were delivered in the in-class presentation. Students, divided into small groups, were instructed to discuss among themselves and come out with answers ('think-pair-share' approach). Our main objective was to make the students recall the things learnt, ensuring the key features of identification, to differentiate abnormal histology in disease conditions from normal histology and understanding the function of each component of tissue (learning and engagement phase). In addition, students were aided in generating a "concept map", which encompasses a diagnostic flowchart ("pattern recognition") helping the students in interpreting the images they observe in the practical session.

3. Laboratory practical sessions start with a briefing session ("priming") where the topic is recapped with the display of histology pictures and key points. Students are then instructed to visualise the slides individually, followed by a detailed demonstration in small groups (one faculty for 8 students). They are made to draw schematic diagrams of the slides discussed. This ensures the transfer of the gained knowledge in a comprehensible form. Practical sessions ended with brainstorming questions which made the students apply the knowledge in different scenarios.

Fig. 2: Protocol for the Flipped classroom.



The flipped histology classes presumably suffice all the four type of learners identified by *Kolb* [14]. The ''divergers'' enjoy engagement and discussion that exposes many different points of view, ''assimilators,'' use theories and concept maps to develop their understanding, ''convergers,'' enjoy solving problems and ''accommodators'' enjoy visualisation brainstorming questions. Feedback from the students were collected using anonymous audience response system (clickers) and tabulated.

RESULTS

We collected feedback from 125 students out of 150 who had attended the flipped histology teaching using audience response system [Table 1]. Out of 125 students, 45% of students agreed and 41% students strongly agreed that the sessions were useful in learning histology in a better way with the mean score being 4.2 [Fig. 3]. 10% of students neither agreed nor disagreed, and 4% students disagreed it. 45% students opined that the flipped classroom sessions highlighted the important topics necessary for the practical examination with a mean score of 4.2. Regarding retention of concepts in a better way, 43% strongly agreed, 31% agreed with the mean score being 4.1. 30% strongly agreed and 43% agreed that the pre-reading material given was very useful with a mean score of 3.9. Majority of students (60%) agreed that the sessions were useful in understanding the topic as a whole with the mean score of 3.7.

On an overall scale, flipped histology teaching method was effective for 98% students than the traditional method for improving their knowledge on histology [Fig.4]. These students felt these

Table 1: Perceptions of students regarding flipped histology classroom.

S.No	Questions	Likert scale (1- strongly disagree, 5- strongly agree) (% no. of students)					Mean score
		1	2	3	4	5	
1	Flipped histology classes were useful in learning histology better	0	4	10	45	41	4.2
2	Flipped histology classes highlighted important topics necessary for practical examination	0	4	18	33	45	4.2
3	Flipped histology classes helped me better in retaining the histological concepts compared to traditional teaching	1	2	23	31	43	4.1
4	Grade the Usefulness of pre-reading material provided	4	7	16	43	30	3.9
5	Grade the effectiveness of Flipped histology classes in making you understand the topic as a whole	0	6	23	60	11	3.7

Table 2: Evaluation of Flipped Histology methodology (according To Kirkpatrick evaluation model for teaching-learning methodology).

S.No	Questions	No of responses (%)	
		Yes	No
1	I Prefer Flipped histology teaching methodology over traditional teaching for improving knowledge	98	2
2	I like to have more sessions of this sort in future	99	1
3	Flipped histology teaching was more engaging and interesting than conventional teaching	98	2
4	I would also recommend same kind of sessions for gross anatomy teaching	47	53

Fig. 3: Students' response on flipped histology classes helping better in retaining histological concepts.

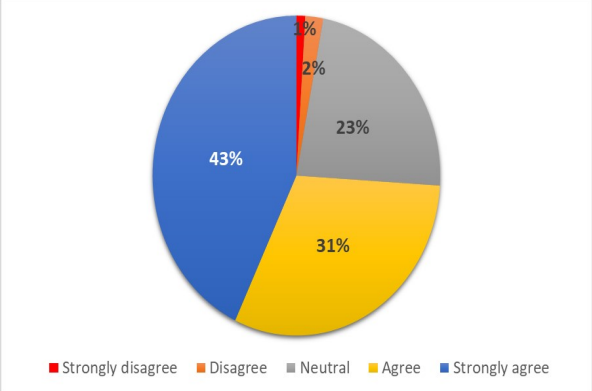
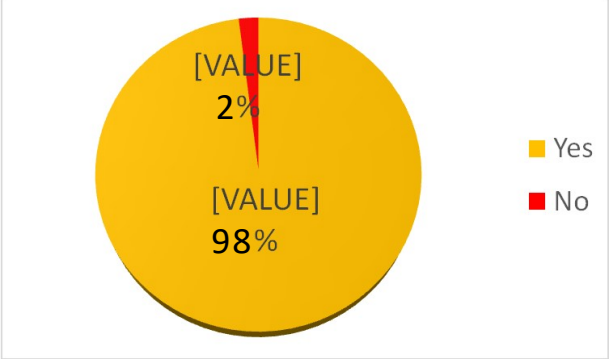


Fig. 4: Preference of students for flipped histology teaching over traditional teaching.



sessions were interesting and more engaging than the traditional method and strongly requested for this type of classes to be continued in the future. When questioning about extending the same method of teaching to gross anatomy, only 47% students gave positive response [Table 2].

DISCUSSION

The aim for developing this methodology was to extend the view of students beyond "visual memorization" and make the students aware of the structure – function relationship which makes them understand the disease manifestation better. *Bloodgood and Ogilive* [15] postulated that, "Histology helps in the students' abilities to identify morphological characteristics of a tissue and integrate their knowledge of the functional aspects of an organ with their observation of a two dimensional microscopic image". Flipped classroom is one of the many new teaching methodologies which gained its significance in medical community over the past years. In this method, students have always been

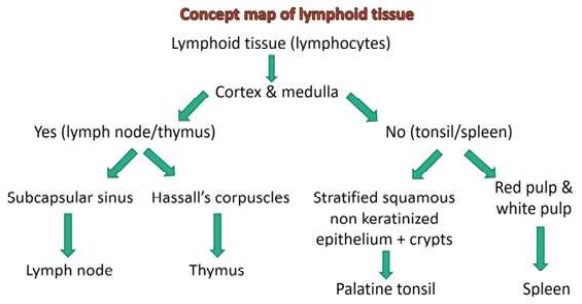
expected to gain some foreknowledge of the topic from the learning material prior to the class.

In-class activities, where the teacher engages the students in a dialogue, has always been the expectation of higher education [16]. With the reduction in time available for anatomy as a whole, incorporating active learning methods become essential. On other hand, the lesson plan for the flipped classroom should take into account that most first year medical students are neophytes, who aren't matured enough to learn from complex learning material. This was side-stepped in our methodology by preparing concise, relevant pre-classroom material based on technology assisted learning theories [17]. It is said that pre-class preparation underlays the observed improvement in student performance in the flipped classroom [18]. Unfortunately, educators need to invest a lot of time to create a self-explanatory reading material, specific to the local settings and these upfront investments is perceived as a barrier to adopt flipped class approach in many settings [19].

In- class activities, which incorporates active learning strategies often promotes students' motivation to learn [20] and studies [21, 22] show that medical students typically indicate a strong preference for the interactive active learning environments in the flipped class relative to traditional lecture-based instruction. It has to be taken into consideration that the role of faculty in flipped class is just to remain as a facilitator, promoting constructivist learning to happen in small groups. At the same time, the questions put forward during active learning activities should range from lower cognitive levels of Bloom's taxonomy to higher levels. This demands the paradigm shift in attitude of teachers, who may have been influenced by teacher-centred learning in their own education, and who themselves have spent most of their careers as teacher-centred educators [23].

Rampant increase in the availability of online materials and high-quality images, has facilitated induction of flipped classroom in histology [5]. In our study, 98% students felt that flipped histology teaching method was effective than the traditional method to improve their knowledge on histology and said that this methodology was interesting and more engaging. Our results lie in concordance with a study [24], where 80% of participants believed that their problem-solving abilities relevant to histology had been dramatically enhanced by joining the flipped classroom. In addition, majority of the students enjoyed the flipped histology classroom learning experience and expressed a desire to attend classes in the future. Another study [25], showed that the objectives based on all of the levels of Bloom's taxonomy had been achieved using flipped classroom teaching. In structured learning environment, discussion will increase the amount of practical knowledge and teachers can help students move into unknown areas (guided inquiry based approach) through a careful choice of task, resources (explained as in "JoHari window") [26]. To consolidate the knowledge constructed via in-class activities, we used the process of "concept mapping" **[Fig. 5]**, graphical presentation of knowledge related to the study topic and demonstrating the relationship between its subdivisions [27]. Concept map, grounded on Ausubel's assimilation theory of learning [28] tries to present information in visual form and this is found to increase the knowledge recall and critical thinking [29]. In our study, 43 % of the students strongly agreed and 31% of the students agreed that flipped histology classes helped in better retention of histological concepts serving the ultimate aim of our methodology. Also. 60% of students agreed and 11% students strongly agreed that the sessions were effective in making them understand the histology topic as a whole.

Fig. 5: Concept map used for teaching histology of lymphoid tissue.



The positioning of value and utility of histology laboratory experiences in first year undergraduate medical curriculum is one of the interesting challenge for the anatomists. Many medical

Table 3: Pedagogical strategies involved in various components of flipped histology classroom.

Components of flipped histology methodology	Pedagogical strategies involved	Place
1. Pre reading material circulated to the students	Self-guided learning	e-learning platforms
2. Questions based approach as a part of in-class activities	Guided inquiry based learning	Lecture hall
3. Discussion among students / group interaction in laboratory	Cooperative learning	Lecture hall
4. Generating concept maps	Motor based learning / Ausubel's assimilated theory of learning	Lecture hall
5. Learning with pre-set microscopes	Instructor guided learning	Histology laboratory
6. Learning with image projection and briefing before practical	Instructor guided learning	Histology laboratory
7. Brainstorming questions at the end of practical	Higher order thinking skills and critical thinking	Histology laboratory

schools have invested significant amount of resources and effort to modify the laboratory experiences (30). Literature (31, 32) suggests that histology laboratory experience can be enriched if four principles are applied at the design stage: Information, Independent self-directed learning, Interactivity, and Integration. Independent usage of microscope can be facilitated by assigning tasks to students, reviewing the didactic visual material projected during the laboratory hours, as in our method. It is reported that a short briefing, brainstorming questions at the end of practical session and team based learning makes the undergraduate histology course more dynamic and student examination scores improved following this (33). Our modification in laboratory experience focused on enhancing the inquiry-based skills in the context of learning how to "read" a microscope slide (34).

Limitations: The amount of feedback from the students was limited. A well modelled exploration of the link between student performances would have made the study more valid. Performing post-test after histology classes, could have strengthened the outcome of the design. Student factors such as lack of preparedness, inadequate background knowledge and poor participation of students can hamper the facilitation of this methodology. This can be addressed by increasing the accountability of students. The methodology demands the change in the role of instructors from their previous role of delivering rote didactics to serving as facilitators. The results of this pilot study, involving two topics in histology, cannot be extrapolated to the entire curriculum.

CONCLUSION

Overall, the feedback from students suggest that flipped classroom teaching model may well serve a subject area such as histology. The instructional design of this methodology is based on solid principles of adult learning and active learning strategies. In class activities were helpful in making the students interested in histology and developing their critical thinking abilities. Generating concept maps provides students with a valuable tool which they can adapt and utilize throughout their education. As with other newer pedagogies, flipped histology classroom also requires significant effort and collaboration between faculties, which is obviously the key determinant for its success. An overwhelming majority of the students found these sessions beneficial and advocated their continued use. Our future goal is to study the difference in the level of performance caused by this methodology before it can be reliably implemented as a validated teaching modality.

Conflicts of Interests: **None**

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