Flipped Classroom: A Concept for Engaging Medical Students in Learning

KULDEEP SINGH[1], RAJIV MAHAJAN[2], PIYUSH GUPTA[3] AND TEJINDER SINGH[4]

From Departments of Pediatrics, [1]AIIMS, Jodhpur, Rajasthan, [3]University College of Medical College, New Delhi, and [4]Christian Medical College, Ludhiana, Punjab; and [2]Department of Pharmacology, Adesh Institute of Medical Sciences and Research, Bathinda, Punjab; India.

Correspondence to: Dr Kuldeep Singh, Dean (Academics), Professor and Head, Department of Pediatrics, All India Institute of Medical Sciences, Jodhpur 342 005, Rajasthan, India. kulpra@hotmail.com

Technological advances have created immense pressure on our younger generation to keep themselves abreast with the newer developments in medical sciences. Educators have to evolve innovative pedagogy to help prepare this generation for future challenges as the training periods are getting relatively shorter. Flipped classroom or Inverted classroom is one such innovation that can empower a learner to develop critical thinking skills and master ways to imbibe vast information by engaging students in active learning process. Reading and understanding are carried at home, and the class-time is utilized for higher levels of learning like analyzing, evaluating, and application of the basic information. This review article is aimed to guide the educators in applying the concept of flipped classroom in their teaching learning armamentarium.

Key words: *Alternative learning strategies*, *Innovation, Inverted classroom, Pedagogy, Teaching methodology.*

G is a faculty member in a medical school, and is responsible for making teaching schedules. Given the time available, it is always a challenge for him to include everything that is there in the syllabus. Feedback from the students and faculty suggested that sometimes, the teachers skip a part of the topic due to lack of time; alternatively, they just read from their slides to 'cover' the topic. Students do not appear to be happy with either. G was advised by a friend to reverse the roles – that is the students should read the material at home and come and discuss the difficult areas in the class with peers or teacher. Inspired by the advice of his friend, he introduced Flipped (or inverted) Classroom.

"Flipping the classroom means that students gain first exposure to new material outside of class, usually *via* reading or watching lecture videos, and then use class time to do the harder work of assimilating that knowledge, through problem-solving, discussion, or debates in the presence of instructor or facilitator" [1]. The model was popularized by Eric Mazur claiming that the learning gains are nearly tripled with this approach that focuses on the student and interactive learning [2].

The concept was first used in 1980's by some passionate teachers who used to distribute reading material to students before their class. Walvoord and Anderson proposed a model in which students gain first-exposure learning prior to class and focus on the processing part of learning (synthesizing, analyzing, problem-solving, *etc*.) in the class [3]. Karl Fisch in 2008 created a video "Shift Happens'' and was credited for coining term as "Fisch Flip" and "Flipped Classroom." With the growth of technology, pre-class assignment is usually delivered *via* video lecture; however, many other innovations have been experimented upon, implemented and evaluated. The flipped classroom approach, though used for years in humanities, has now found its way into medical education [4].

NEED FOR THE FLIPPED CLASSROOM APPROACH

Commonly used teaching-learning strategies are lecture, demonstration, tutorial, practical, clinical and field postings; these are occasionally augmented with seminar, student symposia, debate, role play, and panel discussion. There is a felt need to enable a fresh graduate to develop the key competencies so as to deliver socially responsive health care [5]. Medical education is shifting from traditional objective-based curriculum to Competency-based training with focus on developing Entrustable professional activities (EPA) [6]. One of the skills required for Competency-based medical education (CBME) is cultivating the habit of self-directed and life-long learning [7]. There is a need to introduce new and innovative methods which develop attributes of metacognitive skills, and the Flipped classroom fulfils the demand.

The goal of the Flipped classroom is the shift from passive learning to accelerated learning to foster skills at cognitively demanding levels such as analysis, synthesis and evaluation [8]. Researchers have used flipped classes for postgraduate teaching [9,10]. It has positive effect on

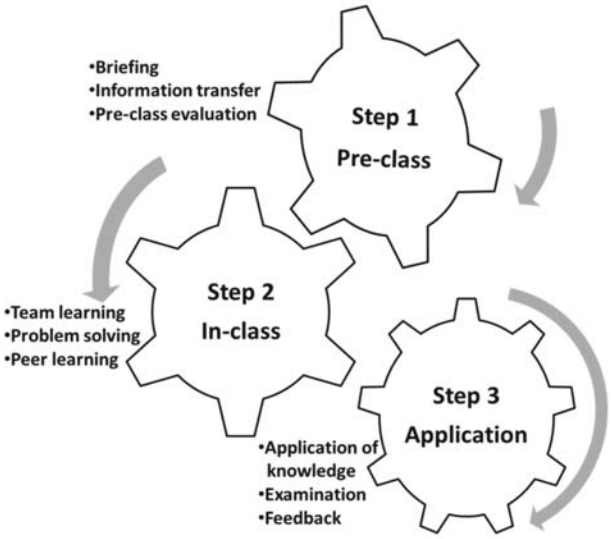

FIG. 1 *Essential steps in Flipped Classroom.*

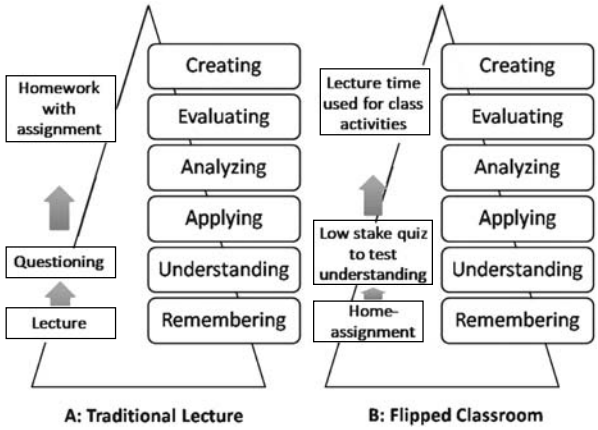

FIG. 2 *The process of traditional classroom (A) vis-a-vis flipped classroom (B) as aligned with revised Bloom's taxonomy.*

active learning [11], and on providing more opportunities for students to engage in critical thinking. It helps them to independently facilitate their own learning, and effectively interact with, and learn from their peers [12] and teachers [13].

FLIPPED CLASSROOM – THE CONCEPT

Flipped classroom essentially consists of three basic components (***Fig.* 1**). From pedagogical principles, based on revised Bloom's taxonomy [14], the process is depicted in ***Fig*. 2**. Planning for using Flipped classroom should include conducting needs assessments, determining content and learning outcomes, and selecting appropriate educational and assessment methods [15].

Pre-Class Assignment

Pre-class activity or assignment can include low-tech as well as high-tech tools depending on expertise available with the instructor. One can begin with a simple tool such as delivering a voice-over lecture on Power Point [16].

Choice of pre-class work: The choice is limited only by the ingenuity of the facilitator. Investigators found that using the pre-class exercises in combination with integrative questions was effective at improving student performance in both the short- and long-term [17]. Unaware of the technique, biology class teachers coined the term 'Learn before Lecture' and found that pre-class introduction of information through worksheets or narrated PowerPoint videos resulted in significant increases in learning gains in a large introductory biology class [18]. Some examples of low-tech tools are summarized in ***Table* I**. For tech-savvy, low-tech tools can also be replaced by high-tech tools, for pre-class assignment (***Table* II**).

Three developments have significantly contributed to the increased spread of Flipped classroom model [21]: (*a*) Screencasts and instructional videos often promoted by websites like YouTube, Vimeo, NBC Learn *etc*; (*b*) Availability of "Open Educational Resources"; and (*c*) Massive open online courses (MOOCs) utilizing learning resource management.

Educators may prepare their own instructional videos,

TABLE I EXAMPLES OF LOW-TECH TOOLS FOR PRE-CLASS WORK IN FLIPPED CLASSROOM

Tool	*Remarks*
Encourage reading [19]	Instructions given to students to acquire basic knowledge before coming to Physiology class.
Teacher prepared conceptual notes as pre-class assignment or recitation [17]	Using the pre-class exercises in combination with integrative questions was effective at improving student performance in both the short and long term.
Conceptual notes through PowerPoint	PowerPoint can be distributed as handouts along with notes.
Problem triggers [20]	Student felt out of their comfort zone initially but quickly adapted to new technology.

TABLE II CONVERTING LOW-TECH INTO HIGH-TECH TOOLS FOR PRE-CLASS ASSIGNMENT

Low-tech tools	*High-tech tools*
Paper based MCQs/quizzes	Online quiz
Comments/questions before class	Google form for survey
Reflective writing or summaries	Moodle based interactive modules
Attendance in the classes	Online presence
Self-report of completion	Using informatics and analytical tools to evaluate completion of assignment

but it is time consuming, involves costly software and requires appropriate expertise. YouTube videos are popular with students, faculty, and public. However, there is a concern on their dependability. It was observed that on the average, only 60% of videos are educationally useful [22].

Power Point is also one of the highly used tools, but standalone slides do not serve the purpose as pre-class assignment. There are many functions available in PowerPoint; the instructor can add a voice-over, record it as a video, annotate with text, and insert a quiz or questions as posers or triggers for in-class activity; with a bit of learning, it may prove to be a handy tool for flipping. It has been shown that the 'hyperlink' function in PowerPoint allows users to advance from one slide to another slide in the presentation when they click on a predetermined word, shape, or image, thereby allowing for a more dynamic and interactive experience [16].

Accountability: Most important challenge for the facilitator is to ensure compliance with pre-class material. This also needs knowledge of best practices in using pedagogical principles [23]. Mixed response was elicited from a study on students' perception of Flipped classroom conducted at Ottawa, Canada [24]. Some students expressed concerns with the method. It was noted that suboptimal student preparation and insufficient direction may limit the student-centered benefits [24].

Quantity of pre-class assignment: The basic principle remains not to overload student with too much cognitive or complex information. By creating a feedback loop between students' work at home and the classroom setting, time on task during class can be improved in both quality and quantity [25]. To be successful, a flipped classroom should have three goals: (*a*) allow the students to become critical thinkers, (*b*) fully engage students and instructors, and (*c*) stimulate the development of a deep understanding of the material [26].

Many studies have shown benefits in relation to student satisfaction and their interest. Controlled trials using a variety of pre-class methods have been carried out, showing positive outcome [27]. However, there is still scope and opportunity for venturing into research from Indian perspective using simple methods of quality improvement.

In-class Activities

The in-class activities are considered the soul of a Flipped classroom (***Box* 1**). This period, unlike in a traditional didactic lecture, is used for interaction with learners so that their queries are clarified; therefore, they are motivated for deep learning and a habit of lifelong self-directed learning is established. The type, amount and quality of in-class activities are determined by the facilitator. The facilitator's primary role is to monitor, guide, and support the learning process of their students. Students will have varied levels of understanding and comprehension. Following completion of their out of class work, and based upon its success by assessing their understanding, one may approach the in-class activities in (*a*) individual or (*b*) group-based activities. Individual activities can be used in advance of group activities to help students navigate a 'higher-risk' group activity and can be helpful for students who need more individual reflective time to learn. Group activities enable the students to bring their individual understanding of the content to the discussion in small groups and draw on each other's knowledge and understanding to forge new understandings and applicability of the concepts.

Any of these in-class activities can be used in solo or in combination depending on our educational objectives. For example, for a class on nutrition, learners can be asked to think of causes of malnutrition. They can then share their perception with their colleague sitting beside them and disclose the most appropriate to whole class. A negative idea can be introduced which the whole class can refute as in reverse brainstorming.

Post-class Activities

Before and after the asynchronous (out of the class) and synchronous (in-class) components of flipping have occurred, teachers in the flipped classroom have an opportunity to increase and sustain student motivation for engagement outside of class time, and to assess learner progress. Various tools are available to assess learning. We may continue to use same assessment tools and compare pre-flip to post-flip class changes. One can also design one's own rubric of assessment or take help of already existing rubrics online. *e.g. https://www.rcampus.com/indexrubric.cfm*. Alternatively, students may be involved in project portfolios, work assignment and surveys.

Box I IN-CLASS ACTIVITIES FOR FLIPPED CLASSROOM

Individual activities

Problem solving exercise

Concept map preparation

Audience response using Clickers

Plickers using smartphone by teachers and cards by students

Individual feedback

Working with students individually who failed to understand

Polling using hands, color papers

Group activities

Think-pair-share

Reverse brainstorming

Prompts and questioning

Nominal group activity to set priorities

Affinity mapping

Modified Fish-bowl, round robin *etc.*

Immediate feedback and assessment technique (IFAT) cards.

Adapted from: Barkley EF, Cross KP, Major CH. Collaborative Learning Techniques: A Handbook for College Faculty, 2nd Edition. San Francisco: Jossey-Bass;2014 [28].

PLANNING EXEMPLIFIED

Now with this guidance – are you ready to flip your first class? The four-step approach can be followed as guidance for flipping the class (***Fig.* 3**). Several studies on Flipped classroom are available for the readers for ready reference [29-33]. Some of the best practices and tips for Flipped classroom are detailed in ***Table* III**. ***Web Table* I** summarizes a few misconceptions about the Flipped classroom and clarifications thereof. ***Box* 2** presents few challenges for the strategy of flipped classroom.

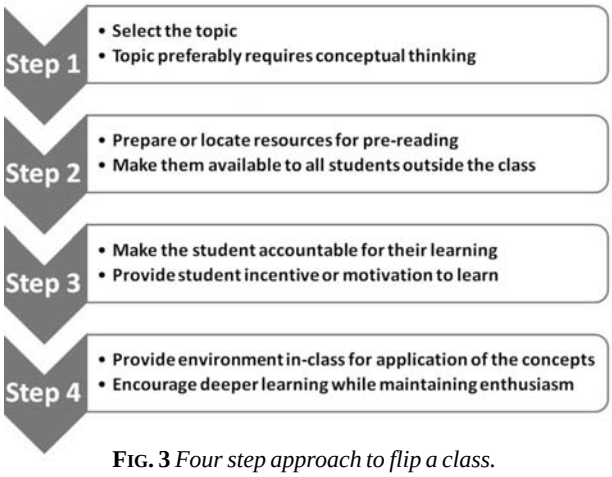

FIG. 3 *Four step approach to flip a class.*

CONCLUSION

Though still in infancy, Flipped classroom is slowly paving its way into Indian classrooms and teachers are devising newer methods to deliver knowledge to students for different subjects. Many strategies can be used to develop self-directed and lifelong learning skills. Once these lifelong learning attributes are inculcated, the

TABLE III BEST PRACTICES AND TIPS FOR FLIPPED CLASSROOM

Best practice	*Application*
Priming and Modelling	Students should be briefed about the flip class activity at the start. The responsibility for gathering basic information should rests with students [34]). Clarify query, create positive environment for imitativeness, collaboration.
Balanced pre-class material	Present balanced material both in quantity and quality considering the understanding level of learners, ensuring not to overburden learner.
Timeliness	Post material at least few days prior to class.
Accountability	Provide an incentive for students to prepare for class. Low stake grading may motivate learner to come prepare with the assignment [34].
Encourage active learning	Maintain enthusiasm, use variety of technique described above, be ready to clarify query.
Make student collaborator	Incorporate student suggestions into the class when feasible and appropriate; Apprise students of changes made based on their feedback.
Time on task	Consider time compensation for complex problem.
Linking activities	Interconnect between out of the class work and in class activity with clear guidelines is most effective [20].
Technology	Using familiar technology with ease of access and flexibility improves students' involvement.
Sharing best practices	A satisfying Flipped Classroom can be shared through blog, research article, online discussion boards and groups.
Faculty development	Create awareness about the innovation and motivation for its use in the classes.

Box 2 CHALLENGES IN FLIPPED CLASSROOMS

1. For flipped teaching to be successful, students must recognize and demonstrate self-directed learning skills.
2. There may be spontaneous questions from students after pre-class activities which a teacher must be able to respond during in-class activity.
3. *Technical issues:* Such as creation, play and access of the material including copyrights may be a deterrent. However, teachers should start their flipped classes with low tech methods as outlined above.
4. *Time constraint*: Observed to be the biggest challenge both for the teacher as well as the student. The teacher should make attempt to use brief, simple material and maintain enthusiasm during the whole process.
5. Student being more tuned to traditional lecture format may dislike it initially. A good teacher will be able to steer the student in right direction.

process of inverted class becomes more satisfying for both instructor and teachers. The concept is evolving, with active discussions on Flipped classroom taking place in social media platforms. The research on these topics is still lacking due to the complexities of human learning. However, body of evidence is accumulating towards balanced use of this new method along with traditional methods of learning.

Contributors: PG,KS: conceptualized the idea; KS: drafted the manuscript; RM,TS,PG: provided intellectual inputs. All authors approved the final version of the manuscript
Funding: None; *Competing interests*: None stated.

REFERENCES

1. Young TP, Bailey CJ, Guptill M, Thorp AW, Thomas TL. The flipped classroom: a modality for mixed asynchronous and synchronous learning in a residency program. West J Emerg Med. 2014;15:938-44.
2. Mazur E. Education. Farewell, lecture? Science. 2009; 323:50-1.
3. Walvoord BE, Anderson VJ. Effective grading: A tool for learning and assessment. San Francisco: Jossey-Bass; 1998.
4. Prober CG, Heath C. Lecture halls without lectures- a proposal for medical education. N Eng J Med. 2012; 366:1657-9.
5. Frenk J, Chen L, Bhutta ZA, Cohen J, Crisp N, Evans T, *et al*. Health professionals for a new century: transforming education to strengthen health systems in an inter-dependent world. Rev Peru Med Exp Salud Publica. 2011;28:337-41.
6. Modi JN, Gupta P, Singh T. Competency-based medical education, entrustment and assessment. Indian Pediatr. 2015;52:413-20.
7. Mahajan R, Badyal DK, Gupta P, Singh T. Cultivating lifelong learning skills during graduate medical training. Indian Pediatr. 2016;53:797-804.
8. Rowe M, Frantz J, Bozalek V. Beyond knowledge and skills: The use of a Delphi study to develop a technology-mediated teaching strategy. BMC Med Educ. 2013;13:5.
9. Rose E, Claudius I, Tabatabai R, Kearl L, Behar S, Jhun P. The flipped classroom in emergency medicine using online videos with interpolated questions. J Emerg Med. 2016;51:284-91.
10. Lin Y, Zhu Y, Chen C, Wang W, Chen T, Li T, *et al*. Facing the challenges in ophthalmology clerkship teaching: Is flipped classroom the answer? PLoS One. 2017;12:e0174829.
11. Jensen JL, Kummer TA, d M Godoy PD. Improvements from a flipped classroom may simply be the fruits of active learning. CBE Life Sci Educ. 2015;14:ar5.
12. Moraros J, Islam A, Yu S, Banow R, Schindelka B. Flipping for success: evaluating the effectiveness of a novel teaching approach in a graduate level setting. BMC Med Educ. 2015;15:27.
13. Smith S, Ganesan R, Martin J. Flipping the practice based pathology laboratory-can it support development of practitioner capability for trainee pathologists in gynaecological cytopathology? J Cancer Educ. 2017;32:662-8.
14. Anderson LW, Krathwohl D. A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives. New York: Longman; 2001.
15. Lockyer J, Ward R, Toews J. Twelve tips for effective short course design. Med Teach. 2005;27:392-5.
16. Stacy GS, Thiel SG. Use of Hyperlinks in PowerPoint Presentations as an Educational Tool. Acad Radiol. 2017; 24:1318-24.
17. Taylor AT, Olofson EL, Novak WR. Enhancing student retention of prerequisite knowledge through pre-class activities and in-class reinforcement. Biochem Mol Biol Educ. 2017;45:97-104.
18. Moravec M, Williams A, Aguilar-Roca N, O'Dowd DK. Learn before lecture: a strategy that improves learning outcomes in a large introductory biology class. CBE Life Sci Educ. 2010;9:473-81.
19. Vujovic P. Improving teaching skills: from interactive classroom to applicable knowledge. Adv Physiol Educ. 2016;40:1-4.
20. Strayer JF. How learning in an inverted classroom influences cooperation, innovation and task orientation. Learning Environ Res. 2012;1:171-93.
21. Tolks D, Schäfer C, Raupach T, Kruse L, Sarikas A, Gerhardt-Szép S, *et al*. An introduction to the inverted/

flipped classroom model in education and advanced training in medicine and in the healthcare professions. GMS J Med Educ. 2016;33:Doc46.
22. Azer SA. Understanding pharmacokinetics: are YouTube videos a useful learning resource? Eur Rev Med Pharmacol Sci. 2014;18:1957-67.
23. Margolis AR, Porter AL, Pitterle ME. Best practices for use of blended learning. Am J Pharm Educ. 2017;81:49.
24. Ramnanan CJ, Pound LD. Advances in medical education and practice: student perceptions of the flipped classroom. Adv Med Educ Pract. 2017;8:63-73.
25. Marrs KA, Novak G. Just-in-time teaching in biology: Creating an active learner classroom using the internet. Cell Biol Educ. 2004;3:49-61.
26. Gillispie V. Using the flipped classroom to bridge the gap to generation Y. Ochsner J. 2016;16:32-6.
27. Lockman K, Haines ST, McPherson ML. Improved learning outcomes after flipping a therapeutics module: results of a controlled trial. Acad Med. 2017;92:1786-93.
28. Barkley EF, Cross KP, Major CH. Collaborative Learning Techniques: A Handbook for College Faculty, 2nd Edition. San Francisco: Jossey-Bass; 2014.
29. Clark RM, Besterfield-Sacre M. Assessing flipped classrooms. *In*: Reidsema C, Kavanagh L, Hadgraft R, Smith N (eds). The Flipped Classroom. Singapore: Springer Singapore; 2017. p.57-74.
30. Tainter CR, Wong NL, Cudemus-Deseda GA, Bittner EA. The 'Flipped Classroom' model for teaching in the intensive care unit. J Intensive Care Med. 2017;32: 187-96.
31. Jump C, Sahn B, Wendel D, Augustine M, Fish S, Albenberg L, *et al*. Using fellows to implement a 'flipped classroom' on an inpatient pediatric rotation. Journal of Family Medicine and Community Health. 2017;4:1112.
32. O'Donnell JF. The Khan Academy: a great opportunity for cancer education. J Cancer Educ. 2012;27:395-6.
33. Sheppard ME, Vitalone-Raccaro N, Kaari JM, Ajumobi TT. Using a flipped classroom and the perspective of families to teach medical students about children with disabilities and special education. Disabil Health J. 2017;10:552-8.
34. Kim MK, Kim SM, Khera O, Getman J. The experience of three flipped classrooms in an urban university: an exploration of design principles. Internet and Higher Education. 2014;22:37-50.
35. Schwartzstein RM, Roberts DH. Saying goodbye to lectures in medical school - paradigm shift or passing fad? N Engl J Med. 2017;377:605-7.

WEB TABLE I MISCONCEPTIONS AND REALITY ABOUT FLIPPED CLASSROOM

Misconception	*Reality*
The Flipped Classroom means video lectures.	It is active learning, problem solving during class.
It requires internet connection.	Paper handout will suffice for communicating.
By providing pre-reading material and videos, work of faculty will be minimized.	In fact, it will require more efforts on part the faculty for preparing in class activities as per the gaps revealed by pre-class evaluation.
This means student will stop coming to the class.	No, attendance increases, freeing time from passive to active learning.
Learning will be better if student see and hears the teacher in person during lecture.	Teacher can adapt his class to the learning level of the student and benefits both the average and advanced learner.
Flipped Classroom will replace all lectures.	Traditional lectures are useful for apprising facts. Mix of both is required based on judgement of the instructor [35].
Flipped Classroom means personalized learning.	The initial flip, rather than being an end, becomes an opening of a door towards other pedagogical strategies. They may lead to peer instruction, problem-based learning, constructionist learning, a focus on collaboration — which help develop higher-level and longer-lasting learning.
The Flipped Classroom makes learning more efficient.	It will not help in memorizing factual data but prepare the student to move ahead.
It requires mastery of technology.	No. This can happen even without technology.