



Effectiveness of the flipped classroom instructional method in physiology teaching among diversified student group—A study from Guyana

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ABSTRACT

Background: The flipped classroom teaching method is more active learning, and more student-centered, it is already gaining popularity across the globe in health science teaching. Available pieces of evidence are still contradictory. Few studies found that the flipped classroom teaching method is effective compared to traditional lectures in promoting student learning in basic medical science. On the contrary, few studies reported that there was no significant difference found when compared with the traditional teaching method. The conflicting results are indicating that more in-depth research is warranted to find the effectiveness of flipped classroom instructional methods. No study was published on the effectiveness of the flipped classroom teaching method among diversified student groups also. The study aims to find the effectiveness of a flipped classroom, among diversified student group.

Methods: The cross-sectional study was adopted under Texila American University, Guyana Campus. Synaptic transmission and membrane potential topics were chosen from the Physiology Course. Sixty-two students from first-semester medical Students from 25 different countries were selected, they were randomly divided into two groups, group-A was assigned for traditional didactic lecture method and group-B is assigned for flipped classroom instruction method for 1 week. The study protocol was approved by the institutional review board.

Multiple choice questions were given according to Bloom's Taxonomy for assessment, course evaluation Questionnaire was also provided after the completion of the experiment to get feedback regarding the course. Data were analyzed by using descriptive analysis on Statistical Package for the Social Sciences 16.

Results: It has been observed that the students participated in flipped classroom teaching has scored significantly high, 54% of students scored above 90% marks compared to those students who have participated in the traditional teaching method, no one from this group scored 90% and above marks, even it has been revealed that students participated in flipped classroom instructional method developed significant improvement in course evaluations from the learning outcome ($p < 0.05$).

Conclusion: The present study has evaluated that the flipped classroom method in physiology teaching is more effective among diversified student group when compared to the traditional teaching method.

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Introduction

Recent advancement in education research develops an entirely new direction in teaching methodology, the flipped classroom is gaining more popularity

across the different educational institute and different health professional program [1].

In flipped learning, it is more active learning, and more student-centered, the traditional classroom

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environment is inverted [2]. Learning materials, such as video lectures, audio-visuals, textbooks, and lecture notes are provided, viewed, and completed by students before the class. When in class, students are engaged in more student-centered activities, such as solving problems, Quiz, and Small group discussions. The teacher always acts as a facilitator. On the Contrary in traditional teaching, most medical faculties' role is to provide information through mostly Didactic lectures, however, in a flipped classroom, students, not medical faculties, are at the center of learning [3]. The goal is to make learning more student-centered and to promote the development of higher-level learning outcomes on Bloom's taxonomy [4].

The ability to correlate and apply basic medical sciences concepts in clinical practice is essential. Traditionally, the teaching mode of basic sciences in many medical schools has been in large-sized lectures. Although the lecture is an efficient way to convey a large amount of information to a large group of students, Didactic lectures have been denounced for failing to engage students and develop the higher-level cognitive skills [5,6].

Few pieces of evidence are suggesting that flipped classroom is effective compared to traditional lectures in promoting student learning in basic medical science.

It has been published that the flipped classroom improves the ability of student's quiz performance in Physiology [7]. Sarah et al. [8] have published an article mentioned that the flipped classroom could be a useful and successful educational approach in the medical curriculum. The flipped classroom is also effective to achieve higher marks in Pharmacology among nursing students [9].

On the contrary, Bohaty et al. [10] have found that students achieved a high grade in pediatric dentistry who were taught in traditional lecture format compared to flipped classroom format. There was no significant difference found in the student's end of the course grade when students were taught in the flipped classroom format reported from Harvard University [11]. Nishigawa et al. [12] published one article, supports that there were no difference at the end of term exam score after comparison of team-based learning and the flipped classroom instructional method.

Recently Jin Ho Beom et al. [11] Published one article mentioned that the Competency assessment after simulation-based training in advanced cardiopulmonary life support undergone by senior medical students randomly assigned to flipped and

traditional classrooms showed no statistical difference in competency between the two groups.

No study was published on the effectiveness of the flipped classroom teaching method among diversified student groups, Students from different countries are already exposed to the different Teaching-learning process, Curriculum, and languages.

The conflicting results are indicating that not only more in-depth research is warranted to find the effectiveness of flipped classroom instructional methods, but also long term study on the effect of the flipped classroom on diversified student groups is needed.

AIMS and Objectives

In an attempt to find the effectiveness of a flipped classroom, among diversified student group, compare student learning of the Synaptic Transmission & membrane potential via the flipped classroom approach and the traditional didactic lecture approach. We assessed the student performance on content-based and case-based quiz questions in the flipped and no flipped approach, as well as the course evaluation questionnaire, which was introduced in both groups to get feedback.

Material and Methods

The cross-sectional studies were adopted under Texila American University, Guyana Campus. Sixty-two first semester medical students from 25 different countries of March–July 2018 session have shown interested to participate in the study. The study protocol was approved by the institutional review board. Students were agreed to comply with the protocol and to give consent for participating in the experiment. All the students were aged between 20 and 25 years. Synaptic transmission and membrane potential topics were chosen from the Physiology Course. The language medium of the Course was English. Students ($n = 60$) were randomly divided into two groups, 31 in each group, group-A was assigned for traditional didactic lecture schedule and group-B is assigned flipped classroom instruction method. Traditional Didactic lectures were taken for 2 hours for each topic in 1 week and all the lecture materials, handouts, reference books list made available to Students through University Learning management system Portal (LMS), mentioned the reference books as well.

Flipped classroom instructional method was scheduled, such as Traditional methods, lectures were replaced with online modules that consisted of several short videos, Uploaded in University LMS

along with handouts of each topic. Two hours' interactive quiz sessions with small group discussion were scheduled for each topic in 1 week, students were divided into six small groups, so each group was comprised of five students, students were encouraged to discuss regarding the probable answer of the quiz within the group. Five minute times were allotted to answer each quiz, students were advised to watch Video, study handouts, and reference books before quiz sessions. I-clicker software was used to record the response from each student during the quiz session. Students from both groups were given a 1-week time for preparation, then 50 multiple choice questions (MCQ composed of 20 content-based and 30 case-based questions according to Bloom's Taxonomy were given for assessment. University LMS Portal was used for MCQ exam. The exam was conducted out of 50 marks.

Each student in each group was provided a one-course evaluation Questionnaire [12] (Table 3) after completion of the experiment to get feedback regarding the course. The Course Evaluation Questionnaire contains Seven Questions with a five-point Likert scale (4-Totally Agree; 3-Agree; 2-No response; 1-Disagree; and 0-Totally Disagree) Unpaired Students *t*-test was used to find out the comparison between the score obtained by Group A and Group-B in Quiz, as well as course evaluation feedback was also compared in between two groups by using *t*-test. Data were analyzed by using descriptive analysis on Statistical Package for the Social Sciences 16.

Result

Thirty-eight girls (61.2%) and 24 boys (38.7%) from 25 countries participated in the current project from the first semester of the MD Programme. Group A obtained (32.29 ± 7.17) and group B obtained (44.0 ± 5.17) in the quiz session. (Table 1)

It has been revealed that 63% of students were able to score 60% or above from group-A, whereas 97% of Students scored 60% or above from group-B (Table 2 and Fig.1).

Group-wise mark analysis was made and it was observed that 54% of students belong to group-B got 90% and above marks, whereas Nobody from group-A obtained 90% and above marks (Fig. 1).

Table 1. Mean ±SD of quiz scores distribution in both group.

	Group-A	Group-B
1.	32.2 ± 7.17	44.09 ± 5.17

Thirty seven percentage of students from group-A have scored below 60% marks, and 3% only scored below 60% from group-B.

A course evaluation questionnaire was introduced after completion of the study to get feedback from students, 24 and 26 students' responses were recorded from group-A and group-B respectively (Table 3). The unpaired Students *t*-test was performed, it has been observed that component number 3, 6, and 7 of the course evaluation questionnaire, mentioning that discussion sessions supported the learning goals of the course, felt well prepared to demonstrate the competencies of the course & well prepared to apply course concepts and skills to solve public health problems showed statistical significant value when it was compared in between group-A & group-B.

Discussion

The flipped classroom instructional method in medical teaching is gaining popularity worldwide. Advancement in technology provides user-friendly tools to upload and recording lecture content and sharing it with students easily. The student-centered teaching approach is comparatively a new method. Few shreds of evidence are available to prove their effectiveness.

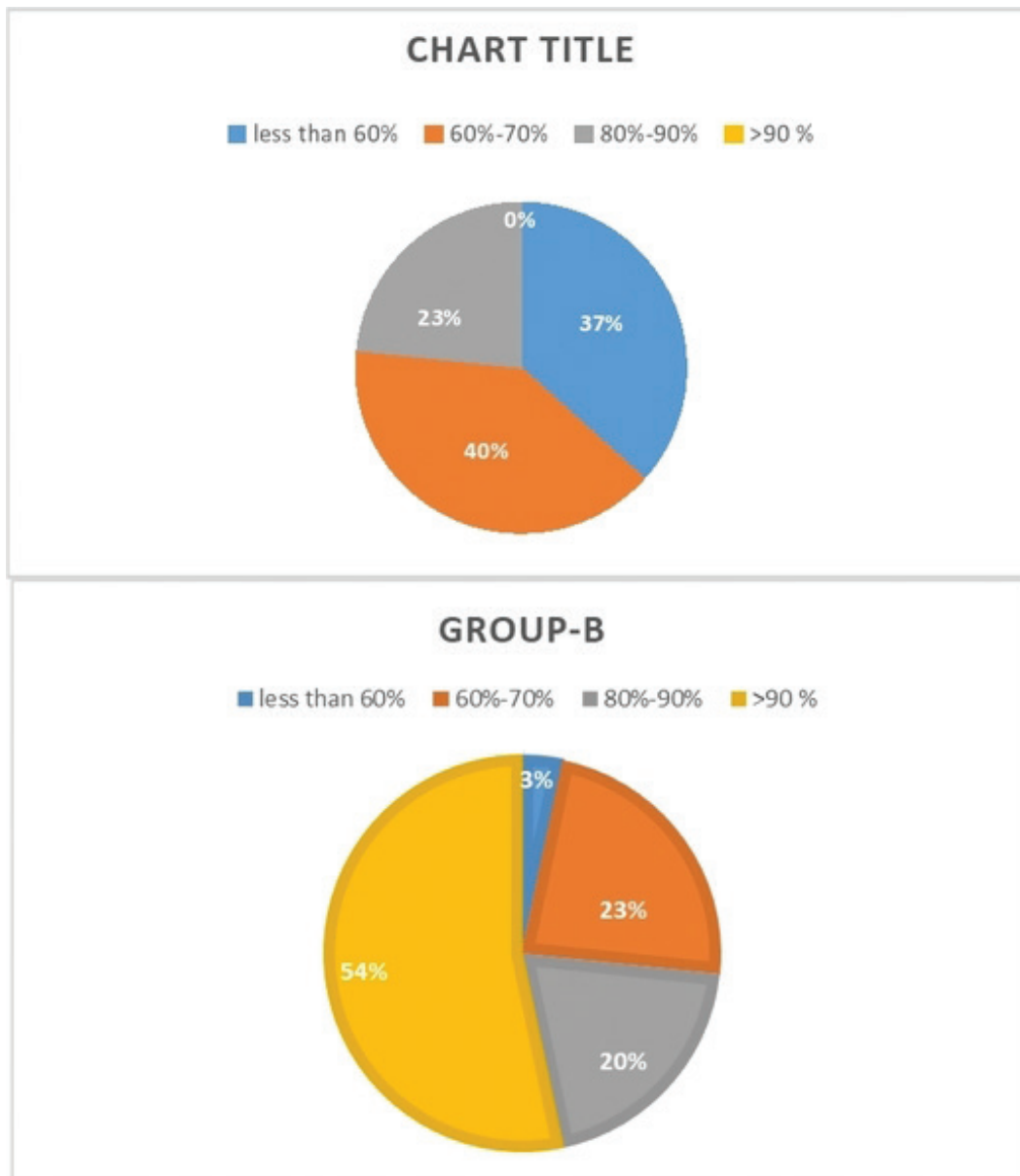
The present study was adopted to find out the efficacy of flipped classrooms in Physiology teaching in a medical school among diversified student groups. Students performed better in the flipped teaching group of our study compared with the traditional didactic lecture group even though the flipped classroom method was new to the students. It has been observed that few studies have concluded the positive effect of the flipped classroom method [13–16].

Nouri et al. [17] reported that lower achievers are also benefited from the flipped teaching intervention more than the higher achievers. On the Contrary, another study has been mentioned no significant differences were reported from flipped classroom teaching when compared with traditional teaching but explained a positive result when students were involved with peer interaction, our study has also incorporated an interactive group discussion session as a part of in-class activity [18], so this could be a reason in the success of the flipped classroom approach of the present study.

Our study has revealed that students belongs to the flipped classroom instruction method not only scored well (Table 1) but also 54% of students able to get above 90% compared to the traditional method, no one scored above 90% belongs to this

Table 2. Quiz scores in different grade in between both groups.

Marks %	Group-A				Group-B			
	Less than 60%	60%–79%	80%–89%	>90%	Less than 60%	60%–79%	80%–90%	>90%
No. of students	11	12	7	0	1	7	6	16

**Figure 1.** Quiz scores in different grades in between both groups.

group (Table 2). It has been observed that group-B Students felt comparatively well prepared for the quiz which reflected in the Course evaluation questionnaire, specifically it was reflected in the last two components of the course evaluation questionnaire, component 6 and 7, mentioning Felt well or very well prepared to demonstrate the competencies of the course and felt well or very well prepared to apply course concepts and skills to solve public health problems respectively (Table 3).

Group B has shown statistical significant value in these two segments of the questionnaire when compared with Group A which supports the efficacy of the flipped classroom method. Component 3 of course evaluation questionnaire also showed statistical significant value which strongly supported that discussion segments have helped student to understand the concept of learning objects in the flipped classroom method, flipped classroom teaching method not only enables students from different

Table 3. Course evaluations from the learning outcome of the synaptic transmission and membrane potential.

Component	Group-A (n = 24)	Group-B (n = 26)	p-value
1) Found the time required per credit for this course compared to other courses is about the same	3.89 ± 0.73	4.26 ± 0.73	0.131*
2) Agreed or strongly agreed the requirements of the course were reasonable for the course credits allotted	3.78 ± 0.91	3.94 ± 0.84	0.585*
3) Agreed or strongly agreed the discussion sessions supported the learning goals of the course.	3.10 ± 0.45	4.05 ± 0.9	0.003**
4) Agreed or strongly agreed they would recommend the course to other students	3.63 ± 0.8	3.57 ± 0.9	0.857*
5) Agreed or strongly agreed the course contributed to the pursuit of their professional goals.	3.26 ± 1.0	3.21 ± 0.97	0.873*
6) Felt well or very well prepared to demonstrate the competencies of the course	2.73 ± 0.73	4.15 ± 0.89	<0.0001**
7) Felt well or very well prepared to apply course concepts and skills to solve public health problems	2.52 ± 0.90	4.26 ± 0.93	<0.0001**

** $p < 0.0001$ statistically significant.

* $p < 0.05$ statistically significant.

countries, different cultures and languages more interested and interactive towards the course, but also develop more interpersonal skills [19].

Physiology is one of the important basic medical science, in-depth knowledge, and a clear concept is highly relevant and important in the clinical training as well as modern research for the future Clinician [20]. Students who were participated in Traditional teaching method group has given positive response upon the course content and credit hours' allotment, but it has been observed that students did not feel confident in terms of demonstrating the competencies of the course and application of course concept in the health sector, when it compared with flipped classroom instruction method.

Conclusion

The present study evaluated the effectiveness of the flipped classroom method in Physiology teaching among diversified student group, in summary, this study provides preliminary evidence that flipped classroom may be an effective teaching method in Physiology among diversified student group, However further long term studies in more depth more benefit.

Limitations and future scope of the study

The limitation of this study is the sample size, which is less and it is recommended to perform a multicenter study in the future, with a larger population. Long-term follows up also needed to get a more accurate result. The groups were analyzed

and compared purely on their skill-based knowledge. Competency-based knowledge assessment was not analyzed.

Conflict of interest

The authors declare that they have no conflict of interests.

References

- [1] Hew KF, Lo CK. Flipped classroom improves student learning in health professions education: a meta-analysis. *BMC Med Educ* 2018; 18(1):18-38; doi:10.1186/s12909-018-1144-z
- [2] Lage MJ, Platt GJ, Treglia M. Inverting the classroom: a gateway to creating an inclusive learning environment. *J Econ Educ* 2000; 31(1):30-43; doi:10.2307/1183338
- [3] Street SE, Gilliland KO, Mcneil C, Royal K. The flipped classroom improved medical student performance and satisfaction in a pre-clinical physiology course. *Med Sci Educ* 2014; 25(1):35-43; doi:10.1007/s40670-014-0092-4
- [4] Krathwohl DR. A revision of blooms taxonomy: an overview. *Theor Pract* 2002; 41(4):212-18; doi:10.1207/s15430421tip4104_2
- [5] Gilboy MB, Heinerichs S, Pazzaglia G. Enhancing student engagement using the flipped classroom. *J Nutr Educ Behav* 2015; 47(1):109-14; doi:10.1016/j.jneb.2014.08.008
- [6] Zheng M, Bender D, Nadershahi N. Faculty professional development in emergent pedagogies for instructional innovation in dental education. *Eur J Dent Educ* 2015; 21(2):67-78; doi:10.1111/eje.12180
- [7] Tune JD, Sturek M, Basile DP. Flipped classroom model improves graduate student performance

- in cardiovascular, respiratory, and renal physiology. *Adv Physiol Educ* 2013; 37(4):316–20; doi:10.1152/advan.00091.2013
- [8] Bohaty BS, Redford GJ, Gadbury-Amyot CC. Flipping the classroom: assessment of strategies to promote student-centered, self-directed learning in a dental school course in pediatric dentistry. *J Dent Educ* 2016; 80:1319–27.
 - [9] Chutinan S, Riedy CA, Park SE. Student performance in a flipped classroom dental anatomy course. *Eur J Dent Educ* 2017; 22(3):e343–9; doi:10.1111/eje.12300
 - [10] Nishigawa K, Omoto K, Hayama R, Okura K, Tajima T, Suzuki Y, et al. Comparison between flipped classroom and team-based learning in fixed prosthodontic education. *J Prosthodont Res* 2017; 61(2):217–22; doi:10.1016/j.jpor.2016.04.003
 - [11] Beom JH, Kim JH, Chung HS, Kim SM, Ko DR, Cho J. Flipped-classroom training in advanced cardiopulmonary life support. *PLoS One* 2018; 13(9):1–12; doi:10.1371/journal.pone.0203114
 - [12] Shiao S, Kahn LG, Platt J, Li C, Guzman JT, Kornhauser ZG, et al. Evaluation of a flipped classroom approach to learning introductory epidemiology. *BMC Med Educ* 2018; 18(1):2–8; doi:10.1186/s12909-018-1150-1
 - [13] Cotta KI, Shah S, Almgren MM, Macías-Moriarty LZ, Mody V. Effectiveness of flipped classroom instructional model in teaching pharmaceutical calculations. *Curr Pharm Teach Learn* 2016; 8(5):646–53; doi:10.1016/j.cptl.2016.06.011
 - [14] Gorres-Martens BK, Segovia AR, Pfefer MT. Positive outcomes increase over time with the implementation of a semiflipped teaching model. *Adv Physiol Educ* 2016; 40(1):32–7; doi:10.1152/advan.00034.2015
 - [15] Lew EK. Creating a contemporary clerkship curriculum: the flipped classroom model in emergency medicine. *Int J Emerg Med* 2016; 9(1):9–2; doi:10.1186/s12245-016-0123-6
 - [16] McCallum S, Schultz J, Sellke K, Spartz J. An experimentation of the flipped classroom approach on college student academic involvement. *Int J Teach Learn High Educ* 2015; 27:42–55.
 - [17] Nouri J. The flipped classroom: for active, effective and increased learning – especially for low achievers. *Int J Educ Technol High Educ* 2016; 13(1):13–33; doi:10.1186/s41239-016-0032-z
 - [18] Foldnes N. The flipped classroom and cooperative learning: evidence from a randomized experiment. *Active Learn High Educ* 2016; 17(1):39–49; doi:10.1177/1469787415616726
 - [19] Hurtubise L, Hall E, Sheridan L, Han H. The flipped classroom in medical education: engaging students to build competency. *J Med Educ Curric Dev* 2015; 2; doi:10.4137/jmecc.s23895
 - [20] Adi AH, Alturkmani HJ. Physiologically lucky: the role of medical physiology in modern medical education. *Perspect Med Educ* 2013; 2(2):99–103; doi:10.1007/s40037-013-0044-5