

Flipped classroom as a novel teaching tool for practical Parasitology

Original Article

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ABSTRACT

Background: Flipped classroom (FC) is a novel pedagogical approach that reverses the traditional classroom and homework system in which self-directed learning (SDL) was done at home. The latter saves the time of the class for discussions and critical thinking to attain higher cognition levels of Bloom's taxonomy. Practical Parasitology needs careful understanding, application, and evaluation of topics in a limited time.

Objective: This study aimed to evaluate FC as a novel teaching and learning tool for practical Parasitology.

Subjects and Methods: This study adopted a quantitative research methodology. We addressed the 3rd year medical students in the academic year 2021/2022 at the College of Medicine, University of Bisha, KSA, and their achievement was compared with that of batch 2020/2021. A pre-class illustrative video about the identification of blood parasites was sent to the students through the Learning Management Systems (LMS); i.e., blackboard, and a formative exam was done through google docs. Mini-lecture and focus group discussions were held at the time of the class. Post-class students' satisfaction was evaluated through an online self-administered questionnaire using google docs in addition to evaluation of their marks in the final course exam questions touching that topic.

Results: The FC proved to be a new tool for most of the students who considered it an easy implementation for the understanding of practical Parasitology. For the students, being engaged, able to discuss, and deal with new technologies throughout the session, supported their competencies as medical students. The overall shortage of time was the main challenge. Overall, there was a significant improvement in students' achievements after the FC.

Conclusion: Flipped classroom could be considered a novel learning tool for practical Parasitology that merges the traditional and student-centered approaches, fosters the students' engagement and enhances their learning with high satisfaction reported by the students.

Keywords: flipped classroom; learning; parasitology; practical; teaching.

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INTRODUCTION

It is well known that learning time was greatly reduced by converting the students into active learners^[1]. Student-centered learning activities are highly recommended nowadays by most medical schools worldwide. This approach ensures students' engagement promoting them to active learners which enhances their satisfaction. Student centered learning was proved to be more beneficial than passive teacher centered learning as students in this approach become active participants, fully engaged throughout the class, and ready for problem solving and critical thinking^[2-6]. Flipped classroom is an example of a pedagogical approach to learning that encourages the student engagement for better achievement^[7-11]. The FC reverses the in-class and at home tasks^[12-14]. In the pre-class phase, the students are asked to self-direct learning at their own pace and place through watching

preprepared short illustrative videos, read textbooks then test their knowledge and understanding by assignments preparation or through formative exams^[5,15-20]. The most important cornerstone that supports these pre-class activities is the use of new technologies to enhance learning^[21-25]. During classroom time, the students are stimulated for deeper discussion through involvement in problem solving of case-based learning which promotes their learning achievements to higher cognitive levels^[6,21,26-28]. Flipped classroom fosters the teacher satisfaction as it empowers him to discover the knowledge gaps of the students that can be easily and rapidly clarified through class discussion^[2,8,29-31]. In the post-class phase, the students are ready to extend their learning by doing an advanced assignment, answering exam questions or complete peer discussion using discussion forums^[32-35].

According to Bloom's taxonomy^[36], students get lower-order cognition (knowledge and understanding) through SDL before the classroom time and later achieve advanced cognition (application, analysis, evaluation, and synthesis) in the classroom phase, where the teacher behaves as an organizer for the discussion. In the FC approach, the class time is highly precious and should be used to integrate and apply the knowledge through problem solving or case-based learning^[32,37,38].

Moreover, Acholonu^[39] advice is to adopt approaches that use problem solving activities in teaching Parasitology curricula in order to stimulate the higher intellectual skills of students to enable them to apply and integrate their knowledge for better practice later on^[40].

Curriculum in University of Bisha, College of Medicine (UBCOM): In 2014, UBCOM was established with the aim of contribution to enhancement of Saudi population health. The UBCOM embraces an integrated, and student-centered educational program after reviewing several curricula of medical colleges in KSA and other international medical schools all over the world. The integrated curriculum in UBCOM is a five-year medical study in the form of 3 phases as foundational medical sciences (Phase I), pre-clerkship (Phase II), and clerkship (Phase III). These phases start after the 1st year, giving students the important basic sciences concepts that are considered the base of the subsequent undergraduate medical study. The 3 phases comprise courses that are conducted in modules that vary in their duration ranging from 2 weeks to 10 weeks maximum.

Phase I represents the 1st round of the curriculum that is an introduction to the basics of medical sciences giving the foundational knowledge regarding the human body structure and function. The students should pass the eight modules of phase I to become eligible for starting phase II modules. In phase II, students become able to integrate the knowledge they received in phase I and this makes them well prepared for the subsequent phase III clerkship. This phase II comprises eight modules of body organs/systems and six modules about other topics that consist of Clinical Pharmacology, Public Health, Basic Epidemiology, Scientific Research, Non-communicable Diseases, and Clinical Skills. Notably, problem-based learning (PBL) is the fundamental educational strategy adopted in the first two phases. It is conducted with other teaching and learning strategies as interactive lectures (IL), team-based learning (TBL), integrated seminars, SDL, hospital, and community field visits, as well as practical sessions, skill lab and bedside teaching for clinical skills. Several IL (5 to 7 per week) are also conducted to reinforce understanding of basic medical knowledge and to give brief illustrations for the difficult subject materials. Seminars and TBL are adopted as active

learning methods to increase students' engagement and to create their critical thinking, communication, skills problem-solving, and work in a team^[41].

Parasitology teaching in UBCOM starts in phase I during the "Principles of diseases, and Hematopoietic System and Host Defense" modules in which the basics of parasitology are conducted; and continues in phase II during the "GIT, respiratory, and CVS" modules, and then in phase III in "General Surgery and Dermatology" modules. This topic is included in the approved course specification for "Hematopoietic System and Host Defense" which is a 7-week course.

Curriculum committee adopts spiral curriculum for teaching and learning with encouragement of introduction of innovative tools for teaching after discussion and getting the acceptance.

Flipped classroom activity: The studied group of students consisted of medical students enrolled in grade three in the College of Medicine, University of Bisha, KSA. Participation was voluntary and unrelated to course results. Acceptance of enrolment was considered as consent^[42,43]. Pre-class illustrative video about how to collect a blood sample, differences between thin and thick blood films, microscopic identification of different stages of human *Plasmodium* species. This video was sent to the students through the LMS (Blackboard). A formative exam was done through the google docs. Mini-lecture and focus group discussions were held during class. A quantitative self-administered questionnaire was sent to the student to get their feedback about that SDL tool.

With respect to the previous layout, the present study aimed to evaluate the effectiveness of FC as a pedagogical approach to improve student engagement and learning for practical Parasitology which will reflect on their satisfaction and scientific achievement.

SUBJECTS AND METHODS

This quantitative cross-sectional study was carried out in the College of Medicine- University of Bisha-Saudi Arabia, during the period from January to February 2021 and from February to March 2022.

Study design: A survey study was designed to evaluate the efficiency of FC "conducted in the academic year 2021/2022" in teaching parasitology practical sessions. The study was revised by the Medical Education Department in the College of Medicine, University of Bisha. The 1st part of the study was in the form of an online survey that was distributed to the students, through e-mails and WhatsApp groups. The survey was formed of two parts: The aim of the 1st part was to identify the experience of the students towards FC, and to describe their perception to the pre-class activities

and the challenges that faced them. The 2nd part of the survey outlined their perception regarding the strategy of FC generally and in Parasitology specifically.

Assessment of students' achievement was performed through considering the pre-FC formative assessment for the 3rd year medical students of the academic year 2021/2022, and the students' achievement in the final exam question touching the topic of interest for batch 2020/2021 receiving "traditional lecture" for this topic, and for batch 2021/2022 receiving "Flipped Classroom" for the same topic.

Targeted students: The study targeted the 3rd year the medical students at UBCOM enrolled for academic year 2020/2021 (n=84); male 58.3% (n=49), female 41.7% (n=35) and academic year 2021/2022 (n=81); male 56.8% (n=46), female 43.2% (n=35).

Methodology: The questionnaire was checked for item appropriateness and comprehensiveness (face and content validity). A five-point Likert scale (1 = strongly disagree; 5 = strongly agree) was adopted within the questionnaires. The data were collected through google documents from September to November 2021. The total agreement was calculated by adding the results of "agree and strongly agree" answers. Student performance was evaluated by comparing their achievements in the pre-class assessment that was conducted online through google docs and their achievements in the Parasitology questions in the onsite final exam. The selected final exam questions were those touching the same topic of the conducted FC activity.

Assessment of students' performance: It was evaluated in two steps. First was by considering the success rate in the pre-FC assessment that was conducted online through "Google Forms" for the 3rd year medical students' enrolled in the academic year 2021/2022. Second step was comparing students' achievements in the selected final exam questions for the academic year 2020/2021, and 2021/2022. The selected final exam questions were those touching the same topic conducted as lecture in the academic year 2020/2021, and FC in the academic year 2021/2022 by the same faculty member and were repeated in the two academic years' final exams. All the questions were rated out of 100 and 60% achievement was considered the success rate.

Statistical analysis: IBM SPSS Statistics Version 20 was used for the whole statistical analyses. Cases with missed values in the survey were excluded from the analysis. Participants' replies to the first part were analyzed and described in percentages. Cronbach's alpha for internal consistency, Bartlett's test of sphericity, Kaiser-Meyer-Olkin measure of sampling adequacy (KMO), Kendall's tau_b correlation and factorial analysis were calculated. Paired sample *t*-test

was used to compare between the marks of the students before and after the sessions. Significant difference was considered when *P*-value < 0.01.

Ethical consideration: The study was approved by the National Research and Ethics Committee, College of Medicine, University of Bisha.

RESULTS

Survey analysis: The total number of participants in the survey was 47 medical students enrolled in the 3rd year, College of Medicine, University of Bisha (58% of the total students' number) with mean age \pm SD=21.3 \pm 0.87. Gender of participations included males (55.4%) and females (44.6%). The distribution of student responses to the first part of the survey outlining their experience, perception of the pre-class activities and challenges that faced them. Accordingly, 74.47% of students reported exposure to FC for the first time, 65.96% found it a helpful tool to support their understanding of practical Parasitology, 42.55% found that the overall shortage of time is the main challenge to apply this novel tool with practical sessions, 44.68% found it valuable to watch an illustrative video before the session (Table 1).

The survey was validated in different ways. The first was checking internal consistency by Cronbach's alpha that was significant 0.893. Also, Bartlett's test of sphericity showed significance (*P*<0.001). Sampling adequacy was measured through Kaiser-Meyer-Olkin (KMO) 0.816. Nonparametric Kendall's tau_b was assessed and showed Inter-item correlation ranging from 0.444 to 0.711. As well as item-total correlation distributed from 0.678 to 0.803. In addition, one factor that was extracted from the survey explained 70.705% of the cumulative variance. The first item in the questionnaire asked about the importance of the pre-session preparation in improving students' discussion during the session time. Interestingly, this item showed the highest means \pm SD (3.87 \pm 0.991) and agreement of 63.8% of students. The second item touched students' perception regarding implementation of flipped classroom as a learning tool for practical parasitology that could support their competencies with means \pm SD of 3.77 \pm 1.146 and agreement percentage of 61.7%. In addition, the third item which asked about the role of flipped classroom in improving students' skills had high scores with means \pm SD of 3.83 \pm 1.09 and agreement rate of 63.8%. The fourth item that treated the engagement throughout the practical session showed the lowest mean \pm SD (3.66 \pm 1.128) as well as the least engagement percent (59.5%). Finally, the last item that checked students' comfort in using flipped classroom as a learning tool for practical Parasitology showed mean \pm SD of 3.70 \pm 1.214 and agreement of 63.8% of students. Means \pm SD of the survey scores were presented in figure (1). Correlating the distribution of

students' answers to the first part of the questionnaire with the second part calculated mean scores showed no significance (Table 2).

Achievement analysis: Attendance for the FC activity was 100% (n=81). The two genders were represented in the sample with 56.8% for males and 43.2% for females. Success rates were calculated in the pre-class assessment and the final exam selected questions that touched the same topic in the FC. In addition, *t*-test was used to compare between students' achievements in the final exam questions touching the same topic between the academic years 2020/2021 and 2021/2022. There

was a significant improvement in students' achievements after conduction of the FC. The percentage of students that passed the selected questions increased after the FC activity; 43% for the post lecture final exam in the academic year 2020/2021, 58% for pre-FC assessment and 79% for the post-FC final exam in the academic year 2021/2022. In addition, there was significant ($P<0.001$) increase in the achievements of final exam selected questions between the two academic years. The mean±SD for the achieved marks in the academic year 2021/2022 final exam selected questions was 77.09±16.48 however, that for the academic year 2020/2021 same questions was 56.80±18.44 (Table 3).

Table 1. Distribution of the responses to the four general questions in the survey.

	No.	Percent
Is this the first time to have a practical lesson with the implementation of flipped classroom as a learning tool?		
1. Yes	35	74.47
2. No	12	25.53
Did you find it valuable to watch an illustrative video about the practical topic before the time of the session?		
1. Extremely valuable	14	29.79
2. Very valuable	7	14.89
3. Somewhat valuable	7	14.89
4. Not so valuable	6	12.77
5. Not at all valuable	13	27.66
Was the pre-class assignment a helpful tool to support your understanding of practical topic?		
1. Extremely helpful	22	46.81
2. Very helpful	9	19.15
3. Somewhat helpful	14	29.79
4. Not so helpful	1	2.13
5. Not at all helpful	1	2.13
What was the main challenge of flipped classroom implementation for practical identification of <i>Plasmodium</i> species in blood film?		
1. An overall shortage of time	20	42.55
2. Earlier work obligations	13	27.66
3. Lack of interest to try a new learning tool	4	8.51
4. The quality of learning material	10	21.28

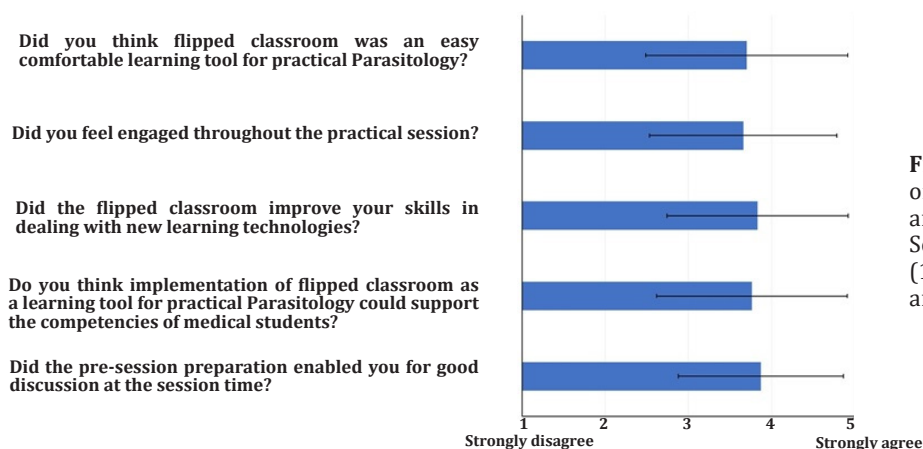


Fig. 1. Students results regarding perception of FC as an effective learning tool generally and in practical Parasitology specifically. Scores are based on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree) and expressed in means (±SD).

Table 2. General questions correlation with the sum of score.

	Coefficient	Significance
Is this the first time to have a practical lesson with the implementation of flipped classroom as a learning tool?	-0.162	0.201
Did you find it valuable to watch an illustrative video about the practical topic before the time of the session?	-0.157	0.177
Was the pre-class assignment a helpful tool to support your understanding of practical topic?	0.080	0.504
What was the main challenge of flipped classroom implementation for practical identification of <i>Plasmodium</i> species in blood film?	-0.031	0.801

Table 3. Analysis of students' achievements.

	Passed	Failed	Total	Mean ± SD
Post lecture final exam (Academic year 2020/2021)	35 (42%)	49 (58%)	84 (100%)	56.80 ± 18.44
Pre FC assessment (Academic year 2021/2022)	47 (58%)	34 (42%)	81 (100%)	60.45 ± 15.53
Post FC final exam (Academic year 2021/2022)	64 (79%)	17 (21%)	81 (100%)	77.09 ± 16.48

DISCUSSION

The FC is also called the inverted classroom, as the traditional lectures conducted in schools and colleges become a homework at home, and the activities that was formerly performed at home become a class time activity^[12,44]. In the present study, 74.47% of students reported exposure to FC for the first time. This agrees with a study which stated that most of the reviewed studies (80%) were conducted on FC implementation at the higher education level^[12]. In the present study, 63.8% of participants considered FC an easy and comfortable learning tool for practical Parasitology. This agrees with a study in which 40% of students reported that an interesting learning time was spent with FC implementation^[45].

In the present study, 63.8% of students considered FC a helpful tool to enhance dealing with new learning technologies. This concurs with a study that reported FC as an attractive tool for researchers interested in the innovative learning tools due to its usage of novel technologies^[46]. In the present study, 59.5% of the students felt engaged, and 68.1% reported good involvement in the discussion during the class time because of good pre-class preparation. This agrees with studies reported enhancement in the level of students' satisfaction by 18%^[47] and engagement by 14%^[48] due to application of FC learning tool.

Besides, 44.68% of students found it valuable to watch an illustrative video about the topic before the time of the session and 65.96% found it a helpful tool to support their understanding of practical topic of Parasitology. This concurs with a study that reported FC as a learning tool to enhance the ability of medical students from the female section of the College of Medicine, Qassim University to achieve better understanding and analysis of the anatomy materials^[45].

On the other hand, 42.55% of students found that the overall shortage of time is the main challenge for applying this novel tool for practical sessions, followed by other sessions with summative assessment as TBL and PBL. Another challenge reported by the students was the quality of learning material as some students mentioned that they cannot get the desired knowledge through watching illustrative videos. The last confronting challenge was the lack of interest to try a new learning tool as they were satisfied by the present learning strategies implemented in their college. Other

studies addressed the challenges for implementation of FC regarding the teachers' perspectives as it needs a longer time for course reformulation^[49] with increase in the workload for the teachers^[50]. From the students' perspectives, FC may be troublesome for those who have poor self-regulated attitude with several approaches. These include inability to get help while out of class^[51,52], inability to correctly schedule their time to understand the at home learning material^[53]; besides it being time consuming^[54], and some students do not prefer it^[55]. From the technical aspect, FC faces great challenges like inequality of technology accessibility^[51], need for students and teachers' technology competency^[56,57], requirements of specific infrastructure^[55].

In the present study, there was a significant improvement in the achievements of the students in the final exam questions than the conducted pre-class assessment regarding the Parasitology topic of interest, 61.7% of the students considered FC as a suitable learning tool supporting their competencies. This is in congruence with a study that reported improvement of the learning performance in (52%) of students, when measured by GPAs, standardized test scores, and course grades because of adopting FC. According to these results, one of the most significant advantages of this model is that it helps to improve learning performance, which is one of the key elements of quality education^[58].

Limitations and challenges: Students of UBCOM were taught legacy teacher-centered curricula during high school and 1st year, that may have affected their contribution and performance in the student-centered activities during phase I. Lack of English proficiency affects students' understanding of the illustrative videos, abilities to engage in optimal discussion, express ideas and communicate effectively during learning activities. Small numbers of students are accepted as our college is a new medical college that enrolls annually limited numbers of students. Earlier work obligations (TBL, PBL, and quizzes) for the students makes them complain of time shortage. FC needs careful orientation for the faculty to be used in a wide scale as a learning tool.

In conclusion, application of FC in teaching practical Parasitology will greatly enhance students' engagement and empower them to get the best benefit from the limited times of the classrooms, the valuable discussion and application of the attained knowledge. Besides, FC is an inspiring pedagogical tool that should be considered in all medical schools adopting student-centered learning approach to enhance students' satisfaction and help

them to achieve the higher cognitive levels in learning medicine for the best medical practice in the future.

As UBCOM has placed a faculty development program (FDP) in the form of a two hourly discussion per week to support its academic staff to enhance their teaching, research, and clinical skills, we will raise the issue regarding the orientation about FC to be included in the agenda of FDP in order to be an accepted tool with implementation in timetables of other courses.

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