Looking at the Levels of Bloom's Taxonomy in a Flipped Classroom Utilizing Study Guide and Interactive Assignment for Undergraduate Medical Students

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Received: 10 Mar. 2020; Accepted: 11 Oct. 2020

Abstract- Our aims were determining the student's views about the effect of using the study guide on advance preparation in a flipped class setting and testing the effect of flipped class on higher cognition. Using a quasi-experimental design in Tehran University of Medical Sciences, one batch was taught using a flipped classroom and another batch by a lecture in 3 sessions. The student's views were assessed using a questionnaire, and the effect of flipped class on levels of higher cognition based on Bloom's taxonomy was measured using two tests in two-time intervals. Seventy-two students believed that the study guide helped them to devote their time to study. Data did not support our hypothesis that flipped class could result in higher cognition one month and four months after the intervention T=-0.75, df=197, *P*=0.45 in knowledge Questions, T=-1.08, df=197, *P*=0.28 in comprehensive questions, T=-0.30, df=197, *P*=0.76 in an application, and T=-0.91, df=197, *P*=0.36 in analytical questions. Study guides could be effective tools to get students to interact with pre-assigned readings in a flipped class context. Our hypothesis that flipped class could result in higher cognition was not supported.

Acta Med Iran 2020;58(12):649-653.

Keywords: Flipped class; Active learning; Medical student; Bloom taxonomy; Study guide

Introduction

Medical students are expected to learn cognitive skills such as creativity, evaluation, and analysis (1,2). Though medical students typically target getting information concerning the course content, the ability to apply, analyze, evaluate, and create is also crucial for their future performance (3,4). The flipped classroom is an active learning strategy that uses a range of interactive activities to reinforce higher-order thinking as well as knowledge of medical sciences (5). In this method of teaching and learning, unlike lecture in which students first learn in the class and then do homework, they first master on content before the class, usually with videos and online material, and then discuss the topics they have learned in greater depth in the class with teacher's instructions (5).

We applied Bloom's taxonomy as a framework in the flipped class setting. Bloom's taxonomy has six categories consist of remembering, understanding, applying, analyzing, evaluating, and creating, which serves as the assessment framework of the current study (6).

Empirical research has shown that the flipped class could result in positive learning outcomes such as satisfaction, motivation, self-paced learning, and self-directedness (7). The flipped class is a widely used method in several disciplines like pharmacy, nursing, dentistry, STEM disciplines, and hospital setting (7). Yet, in the field of medical education, little investigation has been done on looking at the levels of Bloom's taxonomy in a flipped classroom utilizing a study guide and interactive assignment. To our knowledge, Morton studied the impact of a flipped class categorized by Bloom's taxonomy (3). His findings supported his hypothesis, students performed better in a flipped class on analysis items, and there was no difference in knowledge items. His research findings encourage additional research. The added value of our research was in developing an interactive, well- designed study guide beside the pre-recorded video materials for interaction with the content and pre-reading encouragement.

Our aim was to contribute to this research by (a)

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determining the student's views about the effect of using a study guide on advance preparation in a flipped class setting; (b) testing the effect of flipped class on higher cognition.

Material and Methods

A quasi-experimental design using a posttest-control group was used. This design helps to control eight threats to internal validity described by Meredith *et al*., (Meredith *et al*., 1996).

Setting

The study was performed in 2017-2018 in a gastroenterology course for medical students of Tehran University of Medical Sciences cohort of 2015-2016. A system-based curriculum that is organized into four phases, including preclinical, fundamental of medicine, clerkship, and the internship, was launched in 2011. Ten organ system courses form the second phase. We selected the gastroenterology course. All medical students (N=208) in the cohort of 2015-2016 were invited to participate in the study. Three topics were presented titled "acute hepatitis," "chronic hepatitis," and "interpretation of liver enzyme tests" in the form of the flipped classroom.

The pre-intervention phase of the study

Forming the task force and developing the videos

At first, a committee of content specialists, education specialists, designers, and medical students was formed. The teacher was in charge of recording the videos for core content, which was approved by the taskforce. Concurrently, searching the resources was done to provide more relative and ready to use the content. For instance, clinical reference books, along with tables, illustrations, graphs, and open access educational videos available on the internet as complementary materials. Also, for each topic, narrations on slides were recorded in order to transfer the content in a variety of ways to make students use their own preferences.

Developing the study guides

The CREATE model, introduced in medical education by Jean Ker, was used to design the learning materials. The acronym stands for C-convenience, R–relevance, E–evidence-based, A–actively involving the learner, T-technology, E-evaluating the educational impact. Based on this model, a matrix was developed. In this matrix, the educational objectives were listed, then cognitive strategies, e.g., summarization, elaboration, organization, concept map, key points highlight, reinforce reflection questions, and clinical scenarios were aligned to the objectives. For example, if an objective was "students should be able to interpret the signs and symptoms of hepatitis case," the cognitive strategy for better learning was developing a concept map. Students were also asked to provide a summary in the form of a sketch note as a pre-class assignment for each topic. A draft of the guideline was sent to a group of specialists for critique and final approval was obtained on the content and the structure.

Training senior students as facilitators of tutorials

In order to prepare senior medical students to perform the role of facilitator of tutorials, extensive instruction was given on the roles of a facilitator, the script of each case, and the process of tutorials. These students were selected based on the research team knowledge to be able to communicate well and perform the role of a facilitator. We trained six facilitators; every two groups of students had one facilitator.

Developing in-class activities

In order to develop cases that promote students learning, tips on writing cases established by Cohen were used. Then a draft of cases was sent to a group of educationists and clinicians to check for accuracy, authenticity, realism of the cases (8).

Conducting briefing session

Since students needed to know the principles underlying the flipped class, its process, and their responsibilities, we conducted a 60 minutes briefing session on the process of the session and students' responsibilities. This session was conducted by the teacher two weeks before the course.

Measurements

Assessing the levels of bloom's taxonomy

Assessment of the levels of Bloom's taxonomy took place at two-time intervals. One month and four months after the intervention.

To do the first, 16 multiple choice questions were developed in the 1-4 levels of Bloom's taxonomy by researchers. A long-term assessment was utilizing a 16-items test was performed three months after the first assessment. The validity of both tests was approved in a meeting by five experts in the field of medical education and internal medicine. Cronbach's alpha was used to assess the inter-rater reliability of both tests, which was high (0.89 and 0.85). The assessment of levels of Bloom's

taxonomy took place as a posttest in both intervention and control groups.

A subject matter expert (i.e., the teacher) identified the most appropriate responses and graded them on a scale of 0 to 5.

Assessing the students' views about the effect of using the study guide on advance preparation

In order to testing students' views about the effect of using a study guide on advance preparation in a flipped class setting, a tool with open-ended questions was developed. A panel of experts independently sent their suggested items. After two rounds and a review of the related literature, the opinions of 6 faculty members of Tehran University of Medical Sciences were gathered to test the content validity of the scale using CVR and CVI methods both qualitatively and quantitatively. (CVR=0.98). Cronbach's alpha coefficient was used to assess the inter-rater reliability of the questionnaire, which was very high (0.97). Students' views were assessed individually as a posttest measurement in the intervention group.

Intervention

Before class

All medical students at TUMS are divided into two batches by alphabetic order, A and B. All educational processes are the same for both, but the teachers are different. For batch "A," flipped classroom was used for three sessions, and for batch "B," lecture was the teaching method. The method of allocation in two groups was randomized by the comprehensive basic sciences exam scores.

There was a pre-classroom assignment for the intervention group. Students were supposed to study the content (videos and study guides which was available one week before the class on TUMS Learning Management System (LMS), furthermore before the class, they were supposed to develop a concept map of the pre-assigned reading.

In-class interactive activities

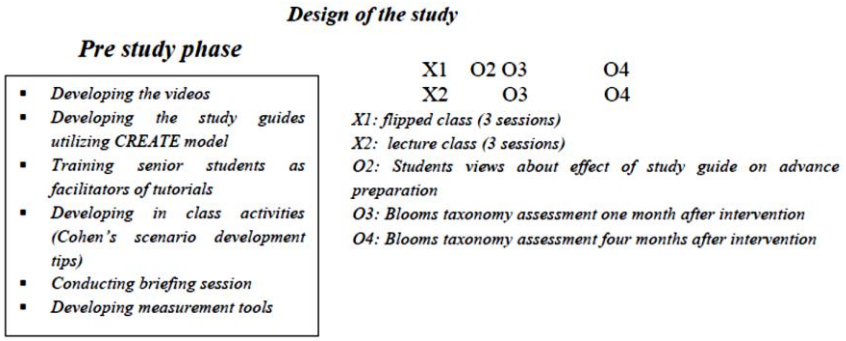
In a flipped classroom, the class time devotes to activities that enhance higher-order thinking, creativity, reflection, peer, and active learning. For instance, role-playing, case-based discussion, debate, problem-based learning. In this study, authentic cases were presented in written form. Then students were instructed to work in their pre-assigned heterogeneous teams to discuss and interpret the signs and symptoms. Facilitators floated in the class in order to encourage and lead students' group work. Then, the case was opened for full class discussion. After that, the teacher summarized the points and answered the questions. 6-8 students were in each team.

Ethical considerations

The Ethical Review Board of the TUMS medical school approved the study. Prior to the study, all participants received information about the study and signed an informed consent form. They were assured of confidentiality and anonymity. They were free to withdraw from the study at any time.

Statistical analyzes

The SPSS 22 was used for data preparation and analyses. Qualitative variables are presented through frequencies (percentages), and quantitative variables are reported as mean (SD). Bloom's taxonomy assessments were tested using *t*-test. (Version 22; SPSS, Inc., 2002).



Results

Of the 103 students in the intervention group, 97 participated in the study; five were removed because they did not complete the questionnaires and did not participate in the flipped sessions. Of the 105 in the

lecture class, 101 students participated in the study.

Of the 97 students in the intervention group, 51 (53%) were women, and 46 (47%) were men; of the 101 in the control group, 53 (52%) were women, and 48 (48%) were men. The grade point average was 16.8 (SD=3.2) for the intervention group and 16.9 (SD=3.01) for the control, the mean age was 20.6 (SD=1.2) in the intervention group and 20.7 (SD=1.1) in control. The data were significant at the 0.05 level. All data were analyzed to check normality.

Seventy-two subjects (74%) believed that the study guide helped them to devote their time to study before attending the flipped class, and 58 (60%) preferred the study guide to the textbook. Sixty-nine subjects (71.6%) were agreed and strongly agreed that algorithms and illustrations in the study guide motivate them for deep learning. Sixty-eight subjects (70.1%) believed the study guide made the self-paced learning process easier. Fifty-six subjects (58.1%) said self-assessment tests, concept maps, and graphs in the study guide helped them learn in an effective way. Fifty-eight subjects (59.5%) mentioned if I didn't use a study guide, I wouldn't study for the flipped class.

However, the data did not support our hypothesis that flipped class could result in higher cognition one month after the intervention (M=4.1, SD=0.91 for the intervention group and M=4.01, SD=0.79 for the control group) T=-0.75, df=197, *P*=0.45 in knowledge Questions. (M=4.06, SD=1 for intervention group and M=3.96, SD=0.98 for control group) T=-1.08, df=197, *P*=0.28 in comprehensive questions, (M=4.07, SD=0.90 for intervention group and M=4.04, SD=0.77 for control group) T=-0.30, df=197, *P*=0.76 in application and (M=4.08, SD=0.93 for intervention group and M=3.97, SD=0.78 for control group) T=-0.91, df=197, *P*=0.36 in analytical questions. This hypothesis was not supported by the data four months after the intervention (See table 1). (Table 1 near here)

Table 1. Blooms taxonomy assessment of medical students in the intervention group versus control group 1 and 4 months after the intervention, Tehran University of medical sciences, 2017-2018

Assessment interval		Remember		Understand		Apply		Analyze	
		M	**SD**	**M**	**SD**	**M**	**SD**	**M**	**SD**
After one month	**Intervention**	4.10	0.91	4.06	1	4.07	0.90	4.08	0.93
	Control	4.01	0.79	3.96	0.89	4.04	0.77	3.97	0.78
	T	-0.75		-1.08		-0.30		-0.91	
	df	197		197		197		197	
	P	0.45		0.28		0.76		0.36	
After four months	**Intervention**	4.42	0.48	4.12	0.79	4.08	0.78	3.98	0.88
	Control	4.25	0.71	4.01	0.89	3.97	0.93	3.91	1.03
	T	-1.89		-0.89		-0.91		-0.54	
	df	167.05		197		197		197	
	P	0.06		0.37		0.36		0.58	

Significances are based on Independent T-test

Discussion

This study explored the medical student's views about the effect of using a study guide on advance preparation in a flipped class setting as well as the effect of flipped class on higher cognition using a quasi-experimental model and control group.

We found that using a study guide could help students to be well-prepared for flipped class. They preferred the study guide to the textbook. Further, they believed algorithms, illustrations, self-assessment tests, concept maps, and graphs in the study guide support deep learning. It stands for the reason that study guides provide deliberate and appropriate guidance on how to learn effectively by giving a focus for the effort and stimulating the thinking about materials. Alizadeh states that learner best learn if instructors utilize engaging combined learning tools like videos, podcasts, animation, and study guide for out of class activities (9). Shihab reported medical students preferred timetable based study guides to outcome-based or problem-based ones. Since study guides are seen as a tool to lead students through their learning (10). Dickson showed the effectiveness of study guides in an introductory psychology course (11). However, we didn't find studies in which utilizing study guides on students' preparation in a flipped class be investigated.

Although the effect of flipped class on higher cognition was anticipated, we found none. Even though some authors claim that flipped class learning is superior to the lecture method, this claim has not been supported by the evidence. Some studies find a positive effect, and

others do not. In our study, we found no effect. An article has been published by David Morton showed that there was no difference in knowledge, but flipped class students performed better on analysis questions in comparison with lecture class students (3). Further, in a well-conducted systematic review on the effects of the flipped classroom in medical education, the lack of evidence on promoting knowledge acquisition above traditional methods was found. However, in most studies on the flipped classroom, one of the main results is the enthusiasm of the participants (12).

Most likely, this study's failure to support our hypothesis may be a consequence of the small sample size. Furthermore, results may have been different if the intervention took place in more than three sessions. Quite possibly, the length of time in this study didn't provide sufficient opportunity for enhancing change in higher-order thinking differences. Moreover, the outcomes would have been different if the lecture-based sessions had been purely passive, not interactive lectures. However, an alternative explanation might be due to compensatory efforts by students. Students tend to adjust their studying to testing requirements (13).

References

1. Sharma N, Lau CS, Doherty I, Harbutt D. How we flipped the medical classroom. Med Teach 2015;37:327-30.
2. Hejri M, Mirzazadeh A, Khabaz Mafinejad M, Alizadeh M, Saleh N, Gandomkar R, et al. A decade of reform in medical education: Experiences and challenges at Tehran University of Medical Sciences. Med Teach 2018;40:472-80.
3. Morton DA. Colbert-Getz JM. Measuring the impact of the flipped anatomy classroom: The importance of categorizing an assessment by Bloom's taxonomy. Anat Sci Educ 2017;10:170-5.
4. Mirzazadeh A, Mortaz Hejri S, Jalili M, Asghari F, Labaf A, Sedaghat Siyahkal M, et al. Defining a Competency Framework: The First Step Toward Competency-Based Medical Education. Acta Med Iran 2014;52:710-6.
5. Moffett J. Twelve tips for "flipping" the classroom. Med Teach 2015;37:331-6.
6. Huitt W. Bloom et al.'s taxonomy of the cognitive domain. Educational psychology interactive, 2004:22.
7. O'Flaherty J. Phillips c. The use of flipped classrooms in higher education: A scoping review. Internet High Educ 2015;25:85-95.
8. Cohen DA, Newman LR, Fishman LN. Twelve tips on writing a discussion case that facilitates teaching and engages learners. Med Teach 2017;39:147-52.
9. Alizadeh M, Parmelee D, Overman I, AlJasem M. Preparing Learners for Learning in the Engaged Learning Classroom. MedEdPublish 2019;8.
10. Khogali SEO, Laidlaw JM, Harden RM. Study guides: a study of different formats. Med Teach 2006;28:375-7.
11. Dickson KL, Miller MD, Devoley MS. Effect of textbook study guides on student performance in introductory psychology. Teach Psychol 2005;32:34-9.
12. Chen CH. Measuring the differences between traditional learning and game-based learning using electroencephalography (EEG) physiologically based methodology. J Interact Learn Res 2017;28:221-33.
13. ten Cate O. What happens to the student? The neglected variable in educational outcome research. Adv Health Sci Educ Theory Pract 2001;6:81-8.