

Effectiveness of team based learning to teach pharmacology for phase-II MBBS students

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Abstract: *Background:* TBL (Team based Learning) instructional methods foster applying knowledge in a highly interactive setting. Furthermore, in contrast to PBL (Problem Based Learning), it is a teacher directed method that encourages student- student interaction. *Objective:* The present study is aimed to assess the effectiveness of TBL over the current conventional tutorial type of teaching-learning strategy. *Materials and Methods:* The present study was conducted in the department of pharmacology of KLE University's J N Medical College, Belgaum for phase II MBBS students. Students were randomly assigned to either team based learning (TBL) or conventional tutorial (CT) groups. Teaching learning sessions were conducted on similar topics of cardiovascular system following mechanics of TBL or tutorials respectfully. Effectiveness of each session was assessed by common pre-test and post test while, the overall performance was assessed at the end by a common test for both groups. The scores of the two groups were analysed using students t-test. A feedback was obtained from the students regarding their experience with TBL. *Results:* There was a significant difference between the pre-CT and pre-TBL scores for Anti-hypertensives ($p \leq 0.0001$) and congestive cardiac failure ($p \leq 0.0002$) sessions while these scores were not significantly different for Anti-anginals and Renin angiotensin system. However, the comparison of post-CT and post-TBL scores were significantly different ($p < 0.05$) for each of the four sessions. The scores of the end of the module test showed significant difference ($p < 0.0001$) between the two group. Most of the students appreciated the mechanics of TBL and were satisfied with it. *Conclusions:* The performance of the students of the TBL group improved in individual sessions as well as the entire module as opposed to the CT group.

Keywords: MBBS Phase II; team based learning; tutorial; pharmacology.

Introduction

“Pharmacology is more than a distinct discipline in medicine; it disguises itself and institutes itself into many interdisciplinary areas of basic clinical science”[1]. In light of this, teaching and learning of pharmacological sciences in the medical curriculum would need a novel, effective and holistic approach to motivate students to learn the general pharmacological principles for effective management of the diseases in patients with the context of perceived health determinants [1]. The pharmacology course in the KLE University's J.N.Medical College, Belgaum, is taught in the second phase for three terms. The course content is mainly delivered in the form of lectures for large groups, small group discussions in the form of tutorials and practicals in the form of laboratory sessions. The lecture continues to be the most common method of delivering information. Though lecturing is an efficient

teaching strategy that can deliver an up-to-date summary of material, retention of the material by students is commonly poor [2]. Lecturing is less than desirable as a vehicle for developing problem-solving or lifelong learning skills. Lectures are delivered to large groups of 100-170 students with very little or no interaction between the teacher and the students or among the student themselves.

The small group tutorial encourages teacher-student interaction, questioning, discussing, working cooperatively and deeper understanding of the subject material [3]. Often, however, the tutorials end up being "small group lectures" leading to little or no student participation and without any scope for critical thinking or application of acquired knowledge. In summary the teaching of the pharmacology course is mainly teacher-

directed and highly lecture based. As per the objectives of the pharmacology course, an undergraduate medical student should be able to describe the general principles of pharmacokinetics and pharmacodynamics, prescribe rationally for prevention, diagnosis and treatment of common clinical conditions, monitor therapeutic outcomes' recognize adverse drug reactions, and prescribe drugs for common ailments. Additionally, MBBS students should develop critical appraisal and thinking skills that support lifelong and self-directed learning skills [4]. Unfortunately, these objectives cannot be satisfactorily fulfilled solely through didactic lectures and lecture-dominated tutorials [4]. Therefore, there is a need for instructional methods that foster active participation when the students learn to apply acquired knowledge to varied life-centered clinical situations.

The Medical Council of India (MCI) realized this and provided regulations in 1997 [5] for undergraduate teaching stating that lectures alone are generally not adequate as a method of training. The MCI therefore, emphasized that every effort should be made to encourage the use of active learning methods and that student should be encouraged to learn in small groups, through peer interactions. All these factors demand the encouragement of diverse student learning styles and equally diverse teaching beliefs and orientations by instructors. Various innovative active learning strategies to overcome teacher dominated approaches could be considered to teach pharmacology at KLE University like problem based learning (PBL), case based learning (CBL), Team Based Learning (TBL). A review of extant literature suggests similar problems are encountered worldwide. In the American University of Beirut (AUB) the pharmacology course was taught through lectures, laboratory sessions and case discussions [6]. AUB students adopted approaches to studying that were passive, test focused, crammed, and/or dependent on short term memory, all of which hindered deep understanding and provided no opportunity for self learning. The medical educators at AUB therefore, introduced interactive learning technique of PBL. This was highly rated by both the students and instructors. However, difficulties were the requirement for substantial physical space and a large number of facilitators.

Therefore, the program developers introduced TBL as an alternative, cost-effective learning technique and found that it provided a better understanding of the content material and led to improved student performance as compared with other approaches. Similarly, the call for change in nursing education by The American Association of College of Nursing supported a relatively new teaching and learning technique, like TBL. It was anticipated that TBL could assist nurse educators in meeting the increasingly high demands of nursing education. Further it could foster critical thinking, professionalism, communication and interprofessional team work [7].

In another instance, the pharmaceutical faculty of University of Oklahoma was concerned with producing lifelong learners as required by the ACPE (American Council for Pharmaceutical Education) accreditation standards [2]. Considering that active learning would foster the skills necessary for lifelong learning, faculty members sought to transition the Pharmacology course from a heavy lecture emphasis to an active learning emphasis. After considering several teaching strategies, a TBL approach was selected. Considering the regulations given by the MCI for undergraduate teaching, and experiences of healthcare educators worldwide, the introduction of instructional strategies that are student-centered is the need of the hour. As noted earlier, medical students in India as elsewhere need to be effective lifelong learners in order to continue to develop personally and practice professionally. The lecture dominated approach can rarely support this emphasis. Some of the innovative strategies to overcome the above mentioned flaws in teaching pharmacology include PBL, CBL and TBL. TBL is easy to organize, requires few space resources and less teacher / instructor resources than, for example PBL and is cost-effective. Therefore we elected to examine the use of TBL with Phase II students.

TBL was originally developed in business schools by Dr. Larry Michaelsen [7]. It advocates self directed learning of course content and student application of new knowledge within small collaborative teams

and full classroom discussions [2]. The approach promotes low (memorization of facts) and high (critical thinking and analytic skills) orders of learning [8]. TBL requires constant student preparation, attendance and participation and gives students the opportunity to learn from peers as they work and negotiate within teams [2]. In contrast to classical lectures that focus on covering content and therefore fostering low level learning, TBL instructional methods foster applying knowledge in a highly interactive setting [6]. Furthermore, in contrast to PBL, it is a teacher directed method that encourages student-student interaction [6]. It could therefore be hypothesised that introducing a TBL strategy would foster self directed, lifelong learners and also facilitate their understanding of the basics of systemic pharmacology as compared to that learnt by conventional tutorials. To determine if our expectations are met, the present study has been planned for a single module focusing on the cardiovascular system. The objective of the present study was to assess the effectiveness of TBL over the current conventional type of teaching-learning strategy.

Material and Methods

A regular batch of MBBS Phase II consisting of 122 students was selected for the study as it could provide sufficient number of students. Neither the students nor the faculty had prior experience with the mechanics of TBL. An orientation session was therefore conducted for both to explain the principles and mechanics of TBL. Ethical clearance was obtained from the institutional ethical committee and consent was taken from the students.

The entire batch was first randomly divided into two groups by asking the students to pick up sealed packets with either TBL or conventional tutorial (CT) written in it. According to the existing teaching time-table tutorials are conducted twice weekly with one half coming on Mondays and second half on Tuesdays. Therefore, we had approximately thirty students for one TBL and one CT session. The students who entered into the TBL group were then assigned into teams of 5 in each by the instructor by asking the students to call out numbers from 1-5 and then grouping the students with same number in one team. These teams remained fixed till the completion of the entire module. Four

topics were selected from the cardiovascular module: Anti-anginals, Anti-hypertensives, Congestive cardiac failure and Renin-angiotensin system. Students in both the groups had prior knowledge of each topic as all had been previously taught in lectures.

Students were notified of pre-class preparation reading material for the selected topics 15 days in advance. In the TBL group students individually answered an 8-10 MCQ Individual Readiness Assurance Test (IRAT) based on the pre-reading material. The questions emphasized on the fundamentals. The students then worked together in their assigned teams on the same MCQ's, discussed the questions and reached a consensus for a correct answer. This was placed on answer sheets that were collected. This constituted the Team Readiness Assurance Test (TRAT). Later the teams presented their answer to the whole group verbally with the justification for their answer. Any related concerns were clarified by the faculty. Subsequently, each team was asked to solve similar 5-6 case scenarios with pertaining questions (MCQ's). Questions were focused on clinical application of pharmacology and were related to the fundamentals of each topic so that a link existed with the questions of readiness assurance test. This was followed by group discussion led by the faculty with the teams reporting simultaneously with the help of cards numbered 1-4 to each case-scenario and justifying their choice. Each such session was conducted for 1.5-2 hours. The entire module went on for 4 weeks. By contrast, in CT groups the discussion of the topic was mainly dominated by the tutor who discussed the content without specific consideration of clinical application or clinical decision-making. In our training of the traditional tutorial group instructions, no alternative approaches or different instructional methods were suggested and no references to TBL were made.

Student Assessment: At our institution the students are marked during each tutorial, the average of which is used to decide internal assessment (IA) marks. The students should score at least 50% IA marks to be eligible for university exams. In the TBL group the IRAT

and TRAT scores were used to assess their performance and decide the IA marks. This made the students responsible for not only the pre-class reading but also their contribution during TBL sessions. Students in the conventional tutorial group were marked by the tutors, which sometimes resulted in universal marks for students in a group. To assess the effectiveness of TBL over the conventional tutorial, both the groups answered a pre-test consisting of 8-10 multiple choice questions (MCQ's) on the pre-notified topic and a post-test for the same questions at the end of the teaching-learning session. In addition, at the end of the entire cardio-vascular module a written test in the form of 30 MCQ's was conducted that also assessed whether the content matter was retained.

Student Evaluation of the Experience: Students were asked to evaluate their experiences with the innovative instructional design at the conclusion of the Cardiovascular module rating from strongly agree to strongly don't agree and don't know [9]. Also, in keeping with traditional TBL approaches, each student received peer evaluation feedback [10] from other members of the team at the end of the module session. Peer feedback examined participation in group activities related to co-operative learning, self-directed learning and interpersonal skills.

Data analysis: To assess the effectiveness of TBL, learning outcomes in the two instructional forms the pre- and post-test scores of both the groups was compared for each session. To assess the overall performance on the cardiovascular module, scores of the students in the end of the module test in the two methods was compared. Data was expressed as mean ± SD and analyzed

using students t-test. P<0.05 was considered as statistically significant.

Results

The entire batch of 122 MBBS Phase II students enrolled in the study was randomly assigned to either a TBL or a CT group. The topics selected for both the groups were identical. The duration of each session was also same for both the groups. We were interested in knowing if the changes in the instructional design and teaching approaches using TBL would be reflected in the outcome knowledge of the students following instruction. For both the groups an MCQ pre-test and a similar MCQ post-test following discussion was conducted on each of the topics.

Significant differences were observed between pre- and post-tests in both the CT and the TBL groups (p≤ .0001). [Table 1] To assess the effectiveness of TBL, the pre-test and post-test scores of the CT and TBL groups were compared. There was a significant difference between in the pre-CT and pre-TBL scores for both the Anti-hypertensives (p ≤ 0.0001) and the congestive cardiac failure (p ≤ 0.0002) sessions while these scores were not significantly different for the Anti-anginals (p =.5135) and the Renin angiotensin system (p = 0.4310). However, the comparison of post-CT and post-TBL scores were significantly different for each of the four sessions [Table 2] (Antianginals p = 0.0171; Anti-hypertensives - p <0.0001; Congestive cardiac failure - p =0.0017; Renin angiotensin system - p <0.0001).

Table-1: Comparison of pre-test CT with post test CT scores and pre-test TBL with post test TBL scores

Topics	Anti-anginals	Anti hypertensives	Congestive cardiac failure	Renin angiotensin system	Grand test
Pre-CT	5.559±0.2540 (N=34)	6.958±0.2018 (N=48)	7.250±0.01280 (N=56)	7.411±0.2262 (N=56)	CT 23.80±0.449 (N=56)
Post-CT	7.912±0.1359 ^{a*} (N=34)	7.958±0.1657 ^{a*} (N=48)	8.054±0.1001 ^{a*} (N=56)	8.607±0.1457 ^{a*} (N=56)	
Pre-TBL	5.794±0.2525 (N=34)	5.267±0.3278 (N=45)	6.231±0.2404 (N=52)	7.160±0.2201 (N=50)	TBL 26.26±0.3075 ^{c*} (N=50)
Post-TBL	8.353±0.1185 ^{b*} (N=34)	9.156±0.1270 ^{b*} (N=45)	8.159±0.1045 ^{b*} (N=52)	9.760±0.07856 ^{b*} (N=50)	

Data are means ± SEM. ^a compared with pre CT scores in each session respectively ; ^b compared to pre TBL scores in each session respectively ; ^c compared to CT scores in grand test ; * p<0.0001

Table-2: p values for comparison of pre and post CT scores with pre and post TBL scores respectively in each session				
Topics	Anti-anginals	Anti-hypertensives	Congestive cardiac failure	Renin angiotensin system
Pre CT Vs Pre TBL	0.5135 ns	<0.0001	0.0002	0.4310 ns
Post CT Vs Post TBL	0.0171	<0.0001	0.0017	<0.0001
Mean \pm SEM values are same as that in Table 1; ns-not statistically significant				

The scores of the end of the module grand test also showed a significant difference between the CT and TBL group ($p < 0.0001$). [Table 2]

Student Feedback: We asked students to complete an evaluation of the sessions. We were particularly interested in their perspective of the overall usefulness of TBL. Most students agreed that the mechanics of TBL helped them to prepare for the class, share their knowledge with teammates and to understand the basics, as well as depth of the subject - in particular with clinical relevance. Students were asked to provide any perspective concerning this type of experience. Some of the positive comments were as follows:

- The pre and post test helped to assess own knowledge
- TBL is a better means of understanding the basic concepts and remembering for long as compared to conventional tutorials and satisfied with knowledge acquired
- TBL was useful and such programmes must be more frequently conducted.
- Learnt more from TBL than conventional tutorials
- Please turn the entire tutorial session for TBL for entire class-
- Group learning improved knowledge in various chapters

Some of the negative comments were:

- Number of tests should be reduced
- Reading material should not be allowed during group work
- Should be for smaller duration and discussion faster
- Include a larger number of questions

Discussion

The present study evaluated the effectiveness of TBL as a novel teaching learning strategy in pharmacology for MBBS phase II students of KLE University at Belgaum, India. To our knowledge this is the first study describing the use of TBL in any medical course in India. This study compared the learning between two instructional designs: Conventional Tutorial (CT) and TBL. The mean of the post-test score of the CT group was significantly higher than its mean pre-test score. This could imply that students did learn from the traditional tutorials as the important points were discussed in the tutorials though dominated mainly by the faculty. Also, as the MCQs for the pre and post test were same, students might have concentrated on the discussion related to the MCQs.

Similar results were seen in the TBL group where the mean post-test score was higher than the mean of pre-test score. One of the reasons could be as mentioned earlier the same MCQs for pre- and post-test. However it could also be attributed to the questions used in the IRAT/TRAT process and in the assignments (clinical problems). The IRAT/TRAT questions were related to fundamentals while the assignments were concerned with elements of higher-order thinking which might have helped the students to solve the post-test more effectively.

The pre-test scores of CT were compared with that of TBL. It was observed that in two of the four sessions (congestive cardiac failure and anti-hypertensives) the mean score was significantly higher for the TBL group. From this we infer that the TBL students were well prepared for the sessions and that they gained from the significant pre-class preparation used

in TBL. Pre class preparation is one of the important stages in TBL. However, there was no significant difference in other two sessions (Anti-anginals and Renin angiotensin system). It could be understood that as anti-anginals was the first topic covered, students might have not appreciated the actual need for pre-class preparation. Similar results were seen for the renin angiotensin system. This similarity may stem from the fact that the renin angiotensin system material is more abstract for students as compared to the hypertensive and congestive cardiac failure concepts which students are more generally familiar with as a result of their clinical postings. Further, as the latter is also more common to students we believe it is likely that they are also more interested in those disease topics.

The post test scores in all the four sessions were higher for the TBL group indicating that TBL was more effective than CT in understanding not only basics but deeper aspects of the subject. The scores of the grand test were also higher for the TBL group. It could be inferred therefore that TBL helped in long term retention of the learned material. The important finding in the present study is that the performance of the students of the TBL group improved in individual sessions as well as the entire module as opposed to the CT group. This finding is similar to other TBL studies [11]. It could be assumed that this improvement might be a consequence of the synthesis and cascade of educational processes including individual preparedness, variety of questions and question formats (IRAT/TRAT, Assignments), learner engagement during team discussions, and peer pressure. These are the fundamental elements of TBL. There are several limitations to this study; First, we believe that it is likely that some amount of contamination of the

discussion that took place in TBL would have reached the students in CT group as we cannot stop students interaction after the class. Secondly, the pre-test and post-test MCQ questions were identical likely leading to some unintended learning based on question redundancy. Third, this being the first time the subjects were taught using TBL, it is likely that we could not find appropriate clinical examples and motivational procedures for the first two sessions where little differences were seen (Anti-anginals and Renin angiotensin system). At the start of this paper we noted that the opportunity for innovation and reform can occur in Indian medical colleges. We believe that the present study provides a useful example of the success of such an innovation.

Conclusion

From our findings we can support the conclusion that TBL is more effective than the CT method. TBL appears to not only provide information about the subject matter but also appears to assist students in retaining facts and concepts for longer durations. Additionally, in this study, TBL appears to ensure better analytical and clinical-reasoning skills so that the students could apply their knowledge in settings of clinical relevance. We would therefore recommend that TBL be used to teach pharmacology for the other modules as well.

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