

# Implementing Team Based Learning of Pharmacology Subject in Year 1 MBBS Programme, UiTM: A Reflection of First Experience and Ways to Move Forward

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## ABSTRACT

This reflection paper describes the implementation of Team-Based Learning (TBL) in the pharmacology curriculum for first-year MBBS students at the Faculty of Medicine, UiTM during the Musculoskeletal (MSK) module. TBL was primarily introduced to overcome the challenges and limitations inherent in traditional tutorial methods, including a shortage of teaching staff and the lack of an interactive, student-centred learning approach. The TBL format consists of Individual Readiness Assurance Test (iRAT), Team Readiness Assurance Test (tRAT), an appeal session to clarify iRAT and tRAT, and an application exercise using problem-based questions (PBQs). This approach fosters active learning, promote critical thinking, and encourage teamwork. This paper also reflects on the process, highlighting the importance of preparation by both educators and students, as well as thorough grouping process of the students to enhance team dynamics. Challenges faced including various technological issues, facilitator inexperience, and the suitability of clinical cases are discussed, with suggestions for improvement. These include having a more diverse case materials and structured peer feedback in the future. The experience showed that TBL encourages student engagement, collaboration, and a deeper understanding of pharmacological concepts. In conclusion, TBL fosters essential skills like critical thinking, communication, and teamwork, which are crucial for future medical professionals. Although TBL requires substantial preparation, it minimizes passive learning and enables facilitators to manage larger groups more effectively. Additionally, TBL approach allows the identification of students' misunderstandings of fundamental pharmacological concepts that requires further explanation by the facilitators. This collaborative approach minimizes the need for multiple facilitators, allowing them to focus on providing targeted feedback and managing larger groups more effectively.

**Keywords:** Team-Based Learning, Pharmacology Teaching, Active Learning, Medical Education, Problem-based learning

## INTRODUCTION

Active learning encompasses a range of instructional strategies aimed at engaging students directly in the learning process, thereby fostering a deeper understanding and retention of material. These strategies include

collaborative approaches, such as problem-based learning (PBL), where students collaborate in small groups to solve real-life case scenarios that require critical thinking skills. Additionally, interactive lectures that integrate activities like think-pair-share or classroom polling are used to encourage active participation. Among the various forms of active learning, TBL has emerged as a particularly effective approach.

TBL was originally developed by Prof Larry Michaelsen who was the central figure in the development of TBL method at Business School, University of Oklahoma in the 1970s (1). He developed this method in view of the increasing number of students with a limited number of educational staff available at that time. With the increase in the number of students, he was concerned about the effectiveness of teaching and learning in a large crowd. So, he came up with the idea of having a special form of collaborative learning using a specific sequence of individual work, group work, and immediate feedback to create a motivational framework in which students are accountable for coming to the class prepared and contributing to discussion. He primarily integrated problem solving learning in TBL as well as basic understanding on the subject matter during TBL.

The TBL method has then garnered interest among other educators from different faculties such as Faculty of Law, Nursing and Medicine as problem-based learning is incorporated in TBL method (2, 3). Since then, TBL has become an increasingly popular method for teaching preclinical as well as clinical undergraduate medical students worldwide. This approach has been used to transform or complement traditional lectures into engaging, interactive sessions that enhance student understanding and retention of complex scientific concepts. In addition, TBL method promotes student-centred teaching and learning activities which is important in preparing students to embrace 21st century skills.

In fostering active learning for our preclinical undergraduate students for the subject of pharmacology and the limitations in the number of department members to allow for traditional tutorial, the Department of Pharmacology, Faculty of Medicine UiTM has taken the initiative to implement TBL to replace the traditional small group sessions by conducting our first TBL with our Y1 MBBS students intake 2023/2024 during their MSK covering 4 topics; Cholinergic Agents, Anticholinergic Drugs, Anticholinesterase and Muscle Relaxants. Each TBL session consists of preparation by educators and students, followed by the TBL session itself which consist of iRAT, tRAT, Appeal, Application exercise and Peer review feedback (4).

## **Preparation Step**

Preparation step is the most crucial step for a successful TBL session. The preparation steps are divided into two parts; i) preparation by the educators in terms of students grouping, preparing material for the students' self-learning prior to the TBL session, preparing the questions for iRAT and Application exercise, choosing appropriate venues to cater to the number of students and ensuring internet connectivity is available in the chosen venues for the session; ii) Preparation of the individual students such as revision of all topics covered in lectures and performing assignments given.

During the preparation step, the pharmacology department members planned a proper guide and adequate materials for the students' self-learning in preparing for the TBL session. All learning materials such as lecture notes, videos, journal articles, information from books or the internet were made ready and shared with the students via the Padlet platform at least a few days before the TBL session (Figure 1). The Padlet link was shared with the Year 1 student representative to ensure the information reached all students. The student representative was also tasked with the responsibility of reminding his peers to complete the necessary self-preparation prior to the TBL session.

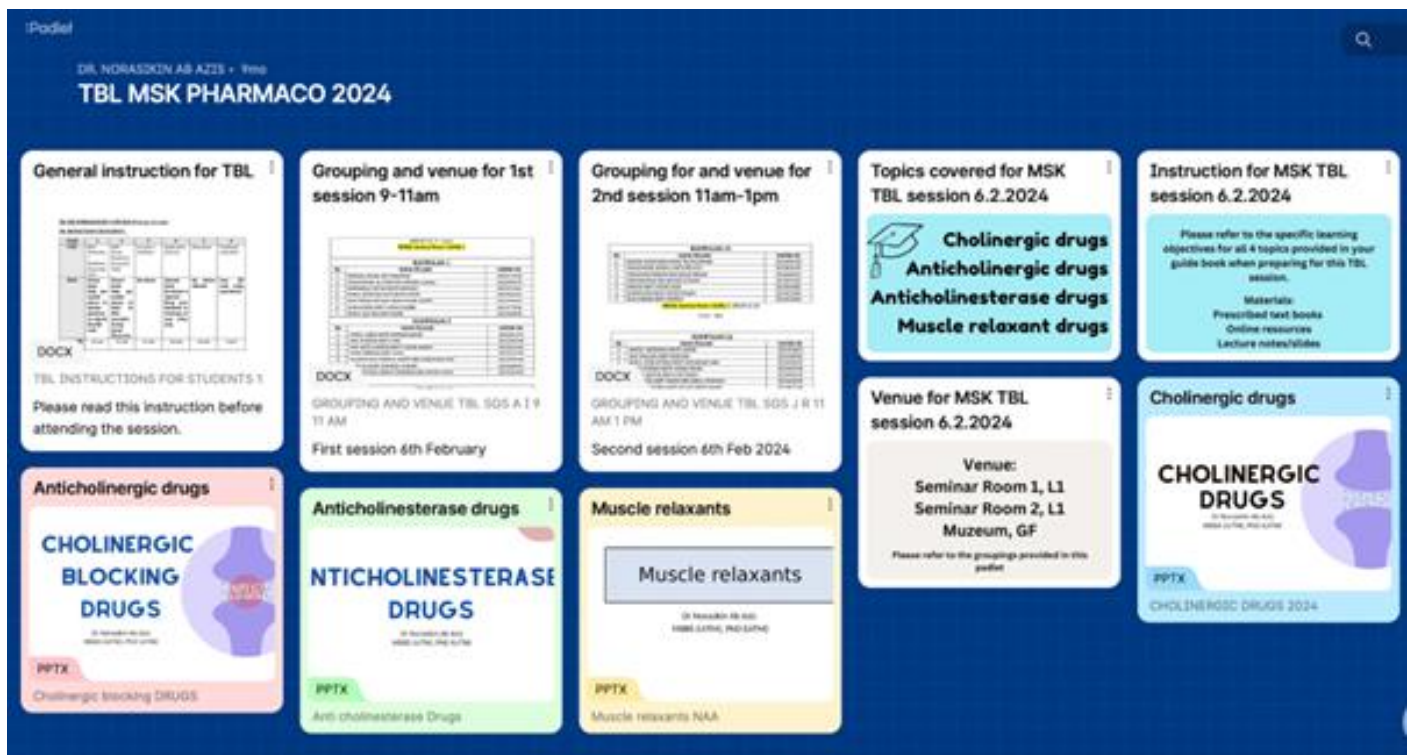


Figure 1: Padlet for TBL session in MSK Module which consists of general instructions, groupings, venues and lecture notes for students to prepare for TBL.

## Grouping of Students

In TBL grouping arrangement, the students were assigned to permanent groups that work collaboratively throughout the course. Each group must consist of different gender and grades from previous exams results (1). The number of students in a group ranges between 7 to 8 people. There was a total of 281 Year 1 MBBS students for the year 2023/2024 in which 51 were repeaters from the 2022/2023 batch who failed their Year 1 exam. The students were divided into 40 groups.

At this point of time, the students have not yet sat for their semester 1 exam and have only been subjected to one end of module test which was the general module (foundation module). The students were assigned to their respective groups based on the results from the end of module test with each group consists of students who obtained high grade, middle grade and low grade. Given that female students comprise about two-thirds of the total cohort, each team was structured to include at least 2 to 3 male students, ensuring a balanced gender mix. The ethnicity of students was also put into consideration during the arrangement. The same grouping of students was used by the physiology department for their TBL. Therefore, the teams remained the same for two departments to enhance team dynamics, trust, continuity of learning and team cohesiveness.

## TBL Session

### iRAT

On the TBL session day, students were seated according to their predetermined groups as described earlier. The session started with an individual readiness assurance test (iRAT) where the students scanned the QR code to access the questions. Students were given 15 minutes to complete 10 single correct answer questions. Students were not allowed to discuss the questions during the iRAT session, and the questions were constructed to test the fundamental understanding about the topics learnt during the preparation step. Each question consists of four answer options. Questions involving application or case scenarios were not included in the iRAT (Figure 2). Students were strictly prohibited from accessing the internet, books, lecture notes, or any sources. We utilised the google form for iRAT to allow us to observe the students' performance

for each question during iRAT session. This approach provided facilitators with insights into the questions that students collectively struggled with. The main challenge of using the applications and technologies is the stability of the internet connection.

**Pharmacology MSK CAL SESSION (TOPIC 1-4) (iRAT)**

|          |   |
|----------|---|
| <b>1</b> | <b>Which of the following statement regarding cholinergic receptor is false?</b>  |
| A.       | Muscarinic receptors are G-protein coupled receptors.                             |
| B.       | Muscarinic receptor activation involves inositol triphosphate.                    |
| C.       | Nicotinic receptor stimulation causes closing of receptor-associated ion channel. |
| D.       | Nicotinic receptor activation causes opening of sodium channel.                   |

|          |  |
|----------|--|
| <b>2</b> | <b>The statement about pilocarpine is true except:</b> |
| A.       | It stimulates muscarinic receptors.                    |
| B.       | It causes <del>cyclospasm</del> .                      |
| C.       | It increases the intraocular pressure.                 |
| D.       | It is used to treat glaucoma.                          |

|          |  |
|----------|--|
| <b>3</b> | <b>The following statement regarding atropine is false except:</b> |
| A.       | It is a non-competitive muscarinic antagonist.                     |
| B.       | It does not cross the blood brain barrier.                         |
| C.       | It causes bradycardia.   |
| D.       | It is used to treat mushroom (muscarine) poisoning.                |

|          |  |
|----------|--|
| <b>4</b> | <b>Choose a false statement regarding atropine overdose:</b> |
| A.       | Blurred vision is one of the symptoms.                       |
| B.       | Flushed skin is a result of dilation of cutaneous vessels.   |
| C.       | Central nervous system effects are rare.                     |
| D.       | It causes dry mouth.   |

Figure 2: Some of iRAT questions with one correct answer for the topics covered during the TBL sessions.

## tRAT

Following iRAT, the students then moved to the team readiness assurance test (tRAT) for another 15 minutes in which they discussed all the 10 questions that they answered during iRAT with their team members. After discussion, they must come to a consensus to select only one option as their answer and scratch one answer option on the answer sheet at a time to identify the correct answer for each question. Ten marks were awarded to the team who managed to answer correctly at the first attempt. Teams who did not manage to get the correct answer during their first attempt would have to re-discuss with their team members and choose another option. Five marks were awarded if they answered correctly on the second attempt. The teams who got the correct answer on their third attempt were given 2 marks and no marks were given on the fourth attempt. Total marks were calculated at the end of tRAT session. For tRAT, the answer sheets were printed for all groups and all the answer options were covered with scratch stickers as shown in Figure 3.



IMMEDIATE FEEDBACK ASSESSMENT - TEAM READINESS ASSURANCE TEST (tRAT TBL)

TEAM NO: 32

**SCRATCH OFF COVERING TO EXPOSE ANSWER**

|    | A | B | C | D | SCORE |
|----|---|---|---|---|-------|
| 1. |   |   |   |   | 10    |
| 2. |   |   |   |   | 10    |
| 3. |   |   |   |   | 10    |
| 4. |   |   |   |   | 10    |
| 5. |   |   |   |   | 10    |
| 6. |   |   |   |   | 10    |
| 7. |   |   |   |   | 10    |
| 8. |   |   |   |   | 10    |

**TOTAL:** 80

Scoring system:

If the answer is correct, a star will appear in the rectangle box.

If an incorrect answer was selected, re-read the question, and try again!

Give a score for each question based on the number of attempts.

10 marks – 1st attempt.  
5 marks – 2nd attempt.  
2 marks – 3rd attempt.  
no mark – 4<sup>th</sup> attempt.

Figure 3: Answer sheet for tRAT session which students must discuss, choose one answer and scratch off the stickers to reveal the answer for each iRAT questions.

## Appeal

After tRAT, the facilitators opened an appeal session for 20 minutes to cater to any question raised by the students. During this session, the facilitators were responsible for explaining and answering any questions, queries and clarifying any misunderstanding of the fundamental concept of the subject. The information on students' performance during iRAT session gave the idea on topics that needed emphasis. Some lecturers gave a mini lecture to emphasise on certain topics to ensure students were able to grasp the basic and fundamental concepts of the subject learned. During the appeal session, students were allowed to express their opposite views on the answer alongside a brief explanation with evidence from their readings or lectures to support their argument.

## Application Exercise

One important element that improves student comprehension regarding the learnt topics during the TBL session is the application exercise. This task encourages students to apply the concepts answered during iRAT and tRAT. The application exercise promotes higher-order cognitive abilities including analysis, synthesis, and assessment. The pharmacology department had been practising PBQ during tutorials in the past, therefore we only needed to refine the already available case to suit its use as the application exercise. Since the topics covered in this TBL was on cholinergic system, the case used was on myasthenia gravis. An example of the case for application exercise is shown in Figure 4.

The clinical case scenario designed mainly focusing on the application of pharmacological knowledge including the mechanism of action, pharmacokinetics, and adverse drug reactions. These questions are

frequently open-ended, forcing students to use their knowledge and draw conclusions from what they understand. In addition, in the group, students were also assessed on the rationale for selecting a particular drug in the clinical case, emphasising its therapeutic indications and relevance to patient care.

During this session, each group received a copy of the PBQ case, and students discussed in groups throughout the exercise. This exercise allowed the students' ability to collaborate, discussed the issue, make decision collectively and write their answers confidently after discussion being made.

Following completion, the representatives from each group presented their answers along with rationale and explanations, and the facilitator led the discussion of the case. When there are differences in answer, other groups were invited to share their viewpoints and asked for clarifications from the presented group. This session creates an interactive learning environment and encourages critical thinking as well as involvement of all students. This activity allowed students to learn from each other's perspectives and insights and provided an opportunity for them to learn from each other's approaches and at the same time deepened their understanding of the subject matter. At the end of the discussion, the facilitator will offer comments on the teams' solutions, emphasising their successes and clearing up any misunderstandings or information gaps.

TBL application exercises are meant to be complex and interesting, encouraging students to use what they've learnt in real-world contexts. Collaboratively solving real-world situations help students get a deeper comprehension of the subject matter as well as improve their critical thinking and decision-making skills. In addition, application exercise in TBL fosters other outcomes that are crucial for medical students such as enhanced critical thinking, better communication skill, leadership skill, and efficient preparation for handling clinical circumstances with more assurance.

**Pharmacology MSK CAL SESSION (TOPIC 1-4) – APPLICATION EXERCISE (PBQ)**

Mrs. AJ is a 35-year-old lady who attended her private doctor with complaints of limb weakness over the past 2 months. The weakness is more pronounced on exertion and is relieved by rest. Over the past month, she said her symptoms have been more frequent and severe, with the symptoms worsening late in the day and improving the next morning.

On examination, there was ptosis of the eyes. The claimed limb weakness could not be elicited. A diagnosis of myasthenia gravis was suspected.

- Besides routine hematological, biochemical, and radiological tests, state ONE pharmacological test that can be done to confirm her diagnosis and name the drug used in this test. (2m)
- State the drug class that you named in Q1 and discuss the mechanism of action of this drug and how it helped in diagnosing this patient's illness. (6m)

Mrs. AJ was treated pharmacologically. However, after 3 months of successful therapy she presented to the Emergency Department with flaccid paralysis of her limbs and respiratory difficulties.

- State ONE drug that can be used in maintenance treatment of myasthenia gravis and give the reason why it is used compared to the drug you mentioned in Q1 (2m)
- State 2 possible causes of her flaccid paralysis and respiratory difficulties. (2m)
- In view of her medical history, state ONE test that can be done to diagnose her current condition. Explain how the test results could be interpreted based on the possible causes you mentioned in Q4. (3m)

After doing the test mentioned in Q5, her condition worsened, and a diagnosis of cholinergic crisis was made as there was no other significant history suggesting otherwise. Treatment was started and she was admitted to the intensive care unit of the hospital.

- Briefly explain cholinergic crisis. (2m)
- Based on its mechanism of action, briefly describe how atropine helps in the treatment of cholinergic crisis (3m)

Figure 4: Problem Based Questions (PBQ) used during the Application Exercise

## Flow, Rules and Duration for Individual TBL Components

Each TBL session took about 2 hours and the flow of the TBL components, rule for the students and time allocated for each component are summarised in Table 1.

Table 1: Flow, duration and rules for each component of TBL

| FLOW               | 1  | 2  | 3                   | 4  | 5                 | 6                             |
|--------------------|--|--|---------------------|--|-------------------|-------------------------------|
| ITEM               | iRAT (individual Readiness Assurance Test)   | tRAT (team Readiness Assurance Test).  | Lecturers' feedback | Application exercise   | Discussion        | Feedback/evaluation           |
| RULE               | <b>Closed book. Only use mobile phone to answer questions on shared link/QR code</b> | <b>Closed book. Only use mobile phone to refer to iRAT questions during group discussion</b> | No device           | <b>Opened book No device is allowed. Bring a textbook or hardcopy of notes only.</b> | No device allowed | Scan QR code using own device |
| DURATION (2 hours) | 15 min   | 15 min   | 15 min              | 50 min   | 20 min            | 5 min                         |

## Educators Feedback

Throughout the entire TBL process, the facilitator provided continuous feedback, clarified any misunderstanding and reinforcing key concepts. We also monitored team dynamics and offer support as needed. Some groups were less active than other groups, therefore facilitators would have to actively encourage group members so that they are actively involved in group discussion to attain their answers particularly during tRAT and Application exercise.

In monitoring team dynamics, we circulated around the room and observed the discussion and collaboration happening in the groups/teams. Facilitator would play their role by probing questions when they see the answers were rushed and not discussed thoroughly.

From this comprehensive feedback process, the facilitator plays a key role in helping students understand the material more deeply, develop their teamwork and critical thinking skills, and ultimately achieve better learning outcomes in the TBL framework.

## Improvement Steps for Future TBL

We encountered several challenges in our early experiences of adapting TBL method to teach pharmacology to our first-year medical students. These included the limited experience of the facilitators, the predictability of frequently used cases, and difficulties in finding suitable venues. To improve the situation, we planned to organize a TBL facilitator training workshop for the facilitators so that all facilitators are experts in conducting an effective TBL. We expect the facilitators' performance to improve with time and with more experience. A wider range of clinical examples with different level of complexity should be considered to further engage students into problem-solving skills. It is important to consider utilizing standardized instruments to assess the personality traits and skills of each student prior to group formation. This approach could enhance team dynamics, fostering more engaging discussions and promoting active learning among group members.

## Resources

In the eagerness to start the maiden year of implementing TBL, we modified existing clinical vignettes to suit our immediate needs. While certainly filling the gap, the quality and suitability of these vignettes,

originally made for discussion during tutorial sessions, were not adequately challenging for the students during the latter parts of the TBL. As such, we planned to improve the quality of the vignettes by including our clinical colleagues in their preparation, thus ensuring accuracy and relevance. During the construction of these new vignettes, a modular approach should be adopted so that their complexity and/or difficulty can be adjusted to suit the students' levels and needs. For example, a case of chest pain used in TBL for year 1 students can be about a straightforward case of costochondritis; in year 2 students it can be about myocardial infarction or pneumonia, depending on other associated symptoms and signs. A wider range of clinical examples with different level of complexity should be considered to further engage students into problem-solving skills.

Besides written vignettes, other types of media can also be utilised to create a more realistic TBL experience. Students can view a recording of an interaction between a doctor and a patient in a clinic, followed by a review of haematological and radiographic examination results.

We also planned to establish a case bank to ensure these vignettes are reused appropriately. In our experience, our students are extremely good at passing on their own learning experiences to their junior colleagues. As such, the same vignettes reused annually lose their impact as incoming students have prepared their answers to these cases beforehand, rather than encountering and solving them during class. Hence, we need enough vignettes that are similar enough so that they address the same learning outcomes but are unique enough so that students need to properly analyse and discuss them (rather than depending on "inherited" answers).

Moving forward, we aim to implement structured peer feedback mechanism within teams to promote accountability and improve individual contributions. Peer feedback encourages active participation, discourages free-riding and fosters constructive discussions within the team. Furthermore, it will help the students to reflect on their strengths and areas for improvement. We did not do the peer feedback for this TBL session however we planned to have a regular peer assessment in the upcoming TBL sessions. One of the known possible peer evaluation methods in TBL to be utilised is the Koles Peer Evaluation Method, developed by Dr David Koles (5). Using this method, students will rate their peers on criteria such as preparation, participation and collaboration using a Likert scale. Students may also provide open-ended feedback including suggestion for improvement for each peer in the group.

## **CONCLUSION**

The collaborative nature of TBL fosters critical thinking, communication, and teamwork skills, which are essential skills for future medical professionals. By encouraging active participation and accountability, TBL helps students to not only grasp fundamental scientific knowledge but also to develop the skills necessary for clinical decision-making and patient care. We observed that TBL reduces the need for multiple facilitators by structuring its phases into preparation, individual and team tests, and application exercises. Although it may seem that a lot of preparation is needed before TBL session, this effort helps to prevent passive learning often seen in traditional tutorials. Moreover, it promotes collaborative and peer teaching within teams, which lessens the demand for constant facilitator intervention. Facilitators therefore can focus on key moments, like peer feedback, and provide a valuable and good quality of learning materials and questions for TBL purposes.

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## Conflict of Interest

The authors declare no conflicts of interest.

## Author Contribution:

All authors contributed substantially to the article's conception, design, and drafting and approved the final version of the manuscript to be submitted. N.R was involved in the overall design of this article. S.N.K, M.H.H and N.A.A contributed to the writing of the subtopics. N.F.A.H involved in overseeing the whole manuscript and ensuring all topics were covered in the article. All authors have selected N.F.A.H to be responsible for all future communication with the journal regarding this manuscript.

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