ORIGINAL ARTICLE

Perception of Combined Team-Based Learning and Project-Based Learning among Undergraduate Medical Students: An Integration of Active Learning Strategies in Medical Education

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ABSTRACT

INTRODUCTION: Team-based learning (TBL) is an active learning session in small groups equipped with an instructional strategy giving students the opportunity to apply knowledge through various phases of activities. The phases are: i) pre-class preparation, ii) individual readiness assurance testing (IRAT) and group readiness assurance testing (GRAT), iii) immediate feedback, and iv) knowledge application phase. However, a 2-hour TBL session could be exhaustive. To address this issue and improve students' enthusiasm towards self-learning process in TBL, project-based learning (PrBL) was incorporated in the final phase of TBL. This pilot study aimed to evaluate the perception of students on the implementation of combined TBL-PrBl in teaching and learning activity. TBL-PrBl also addresses the creativity element of the 21st century learning skills. **MATERIALS AND METHODS:** This cross-sectional pilot study was conducted among preclinical students enrolled in a Pathology course, involving 44 students. The research instrument was a validated questionnaire which assessed four key components in TBL namely; i) teamwork skills, ii) motivation, iii) subject-specific knowledge comprehension, and iv) overall satisfaction. **RESULTS:** Most students believed that TBL-PrBl improved teamwork, thinking skills, and enhanced understanding. 59.1% preferred TBL-PrBl over the didactic lecture, and 63.6% agreed that TBL-PrBl should be continued in the teaching and learning of Pathology. **CONCLUSION:** Based on the findings, TBL-PrBl has the potential to fulfil the 21st-century learning skills and fills in the gap of the limitation imposed by the traditional TBL.

Keywords
team-based learning, project-based learning, IRAT, GRAT

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INTRODUCTION

Team-based learning (TBL)

Team-based learning (TBL) was first initiated in medical school in the year 2001.[1] It is "an active learning and small instructional strategy that provides students with opportunities to apply conceptual knowledge through a sequence of activities that include individual work, teamwork, and immediate feedback".[2] The main objective of TBL is to go beyond the scope of the subject content by providing opportunities for students to apply knowledge and solve the given problems themselves.[2] Compared to the traditional, lecture-centred learning sessions, TBL encourages active student participation.[3,4] TBL is performed in several phases namely: i) pre-class preparatory phase where students are given learning material one week in advance, followed by ii) in-class readiness assurance test (RAT) phase, iii) timely feedback phase, and iv) the knowledge application phase.[5]

The idea is to engage students in individual learning processes while inculcating teamwork.[2] This helps to improve communication and social skills.[4] As more time is allocated for problem-solving and discussion among team members, TBL greatly improves students'

comprehension and retention of information.[6,7] Additionally, compared to the traditional lecture-centred learning method, TBL addresses the challenge of ineffective mass lectures, particularly when the availability of experts is limited.[7,8] As this learning method is a student -centred approach, TBL has been largely adopted in numerous medical schools aiming at producing graduates with critical thinking and capabilities to apply knowledge.[9,10]

Project-based learning (PrBL)

PrBL is a distinguishable form of teaching and learning activities (TLA) because of the "project" component that is not present in other forms of TLA.[11] The learning process of PrBL requires students to complete several steps in problem-solving that include i) defining problems, ii) discussing issues, iii) designing a model, iv) analysing data, and v) sharing findings with peers.[11] PrBL has been proven to improve students' attitudes towards self-learning, stimulate creativity and their higher-order cognitive skills.[12,13] PrBL has been widely utilized in many fields including science and mathematics.[14,15] However, only 20% of studies have been applying PrBL in a higher education setting.[16] A study in a clinical setting of medical school revealed that PrBL is an effective measure to inculcate empathy towards patients.[17] Thus, PrBL could also be applicable in theoretical learning of medical knowledge in preclinical subjects.

TBL vs. PrBL

The major phases of TBL include i) pre-class preparation, ii) readiness assurance test (individual and group), iii) feedback session and iv) theoretical application phase.[5] Meanwhile, in PrBL, the phases comprise of i) timely project planning based on a fundamental question, followed by ii) constructing a relevant model, and iii) presentation which test the model's applicability in a given real situation.[18] Both TBL and PrBL are student-centred learning methods accomplished in a group.

Combination of TBL-PrBL

In our faculty, TBL was introduced in 2022 intended to incorporate student-centred learning to enhance independent skill acquisition.[9] In the early phase of TBL implementation in our faculty, our preliminary study suggested that most students enjoyed learning via TBL method and most agreed that TBL should be incorporated in the curriculum. However, some preferred the traditional lecture-based methodology. Hence, we attempted to improve the current TBL method. Despite the advantages of TBL, some showed lack of participation from team members who were insecure of their knowledge, language, and communication skills.[9,10] Our observation also revealed that students were focusing more on the earlier phases such as IRAT, GRAT and feedback session. The lack of interest in the knowledge application phase may be due to exhaustion towards the end of a 2-hour period.

In our effort to overcome this issue and to enhance students' creativity and encourage everyone's contribution to the session, project-based learning (PrBL) was incorporated in the final phase of TBL. Current TLA in our faculty is outcome-based with a hybrid of traditional subject-based and system-synchronized. TBL was recently introduced to diversify and integrate student -centred learning methods. The 21st-century learning skills outlined the 4Cs elements which include Critical thinking, Creativity, Communication, and Collaboration which TBL addresses.[19] However, the creativity element could be limited in the medical theoretical learning phase, since it is traditionally bound to vast and detailed subjects that run within a packed duration of time.

The integration of different TLA methods in a single learning session such as the combination of TBL with case-based learning (CBL), and PBL with CBL have been performed and proven to effectively enhance academic and clinical performance.[20,21] This study is the first to explore on the combined TBL-PrBL method. As a preliminary stage, we incorporated PrBL as an element in TBL that could explore students' creativity in medical subjects.[2,19] In this pilot study, the objective is to evaluate students' perception on the implementation of TBL-PrBL in a single teaching-learning session of Pathology module. The finding of this study is hoped to serve as a basis for future research and improvement in medical curriculum setting.

MATERIALS AND METHODS

Study Design and Setting

This cross-sectional pilot study was conducted among second-year pre-clinical students at the Faculty of Medicine and Defence Health, Universiti Pertahanan Nasional Malaysia (UPNM) from April 2023 - June 2023. UPNM serves both civilian and cadet students, with the latter preparing for careers in the military upon graduation.

Sample Size and Sampling Techniques

Universal sampling method was employed involving all 44 Year 2 medical students enrolled at the Faculty of Medicine and Defence Health, UPNM. A minimum of 30 respondents is sufficient for determination of questionnaire reliability.[22]

Data Collection Tools

Data was collected using a validated questionnaire adapted from Khan et al. (2020), designed to evaluate four primary domains; i) teamwork, ii) students' motivation, iii) subject-specific knowledge understanding, and iv) satisfaction.[23] The questionnaire was administered online, with voluntary participation after providing informed consent. Responses were recorded on a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The total score was calculated by summing the scores of all items. The internal consistency of the 10 items was assessed using Cronbach's alpha, yielding a reliability coefficient of 0.986.

Intervention: Combined TBL-PrBL session

The topic focused in this study was chronic liver disease and portal hypertension, a critical topic within the pathology module, and applied a combined Team-Based Learning (TBL) and Project-Based Learning (PrBL) approach. Figure 1 illustrates the structure of the TBL-PrBL method.

Phase 1: Pre-class Preparation

Students received a lecture video and supplementary materials on liver disease two weeks prior to the TBL-PrBL. The objectives and study materials were communicated in advance, requiring students to prepare based on the provided content.

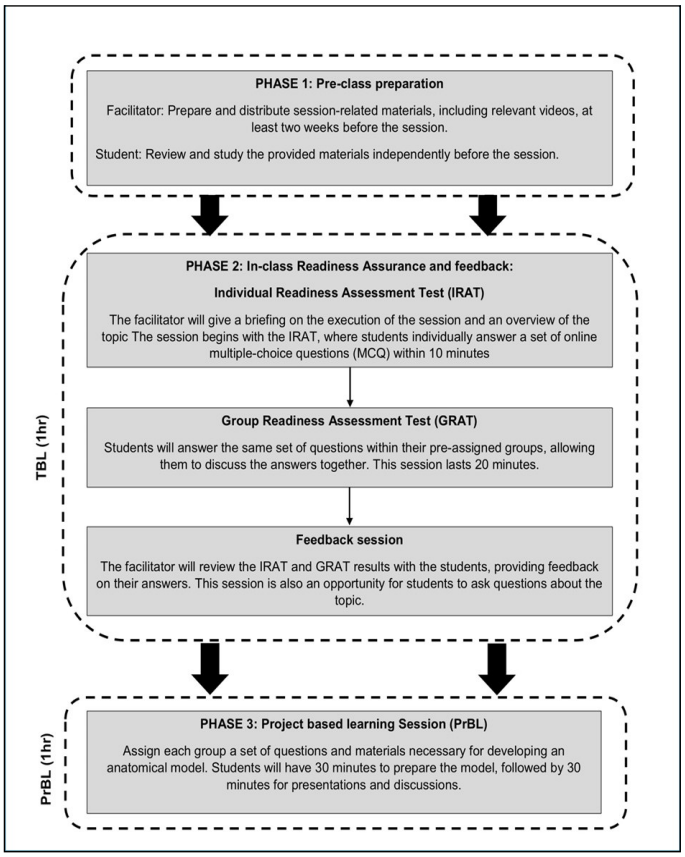

Figure 1: The phases of team-based learning (TBL) with incorporation of project-based learning (PrBL) in the final phase of teaching-learning activity.

Phase 2 TBL: In-class Readiness Assurance and feedback

The in-class session began with an Individual Readiness Assurance Test (IRAT) consisting of 10 multiple-choice questions (MCQs) delivered via the online platform (Kahoot). This was followed by the Group Readiness Assurance Test (GRAT), where students worked in predefined groups to discuss the MCQs. Groups were seated in a circle to facilitate effective discussion. The IRAT component aimed to evaluate understanding of the topic based on the preparatory materials, primarily testing the cognitive aspects of the session. The subsequent GRAT assessed both cognitive and affective domains, including teamwork, interpersonal skills, and communication abilities, as students collaborated to determine the correct answers.

Phase 2 TBL: Feedback session

A comprehensive discussion of each question, with detailed feedback was provided to each group. The instructor facilitated the session by reviewing each question and its corresponding answer, ensuring that students understood the rationale behind the correct responses. During the discussion, the instructor did not only clarify the correct answers but also addressed common misconceptions and errors that emerged during the IRAT and GRAT sessions. This allowed students to reflect on their thought processes. Additionally, the feedback session served as an opportunity for students to ask questions and engage in further discussion, promoting a deeper understanding of the subject.

Phase 3 PrBL: In-class application

Here, students transitioned from traditional clinical application to PrBL. Each team was tasked to create an anatomical model related to chronic liver disease and use it to answer clinical pathology-related questions. Teams were given 30 minutes to prepare their project, where all groups received the same prompt as shown in Figure 2.

1. Draw or construct a model of portal system and portosystemic anastomosis
2. Based on the model (in 1), describe the pathophysiology of portal hypertension and the given clinical manifestations:
    a. Oesophageal varices
    b. Haemorrhoids
    c. Caput Medusa
    d. Splenomegaly

Figure 2: Phase 3 Project-based learning instruction and questions given to students before project building.

While traditional PrBL involves several steps, including preparation, planning, and execution, this study employed a more streamlined approach with predetermined outcomes to facilitate student engagement.[23] Despite a more structured PrBL, students were encouraged to exercise creativity in developing their models. Raw craft materials such as paper, straws, glue, and plasticine were provided in advance to save time sourcing materials. Using the completed anatomical models (Figure 3), the groups were given 30 minutes for presentation and a question-and-answer session. All 3 phases were completed within a 2-hour period on the same day.

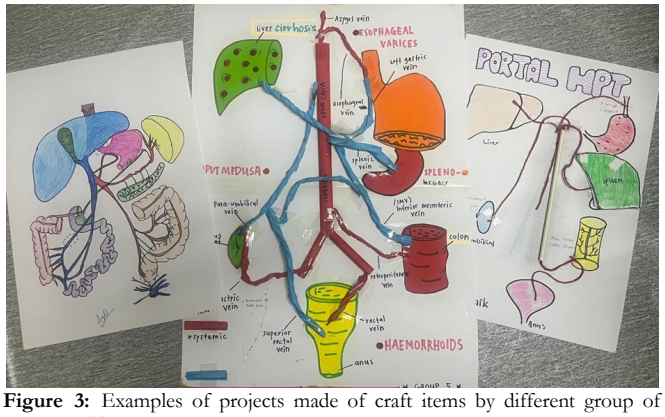

Figure 3: Examples of projects made of craft items by different group of students. The portal system and portosystemic anastomosis models were utilised by students for presentation on the given questions.

Statistical Analysis

Data was coded and entered into Microsoft Excel and analysed using IBM SPSS® Statistics v26 (IBM Corp., New York, USA) statistical software. The average score for each student was calculated on a 5-point Likert scale. The 5-point Likert scale responses were combined into 3 different categorical variables; i) 'agree' (strongly agree plus agree), ii) 'neutral', and iii) 'disagree' (strongly disagree plus disagree) for Chi-Square test. Chi-Square test was used to measure the associations between the different categorical variables (agree, neutral, and disagree) among the male or female students.

RESULT

All 44 students agreed to participate, 25 (56.8%) were female, and 33 (75.0%) were Bumiputra.

Table 1 depicts the student's perception on the combined TBL-PrBL session. Based on the responses, majority agreed that this method helps to improve teamwork skills (4.25±1.08), motivate to learn Pathology (4.16±1.12), expand reasoning skills (4.18±1.08), promote better understanding of the subject matter (4.27±1.11), stimulates thinking (4.20±1.07), reduces misconceptions about the topic (4.11±1.15), helps relate pathological principles to real life situation (4.20±1.07) and helps to gain an in-depth knowledge about the subject (4.09±1.18).

Despite majority agreeing that they preferred TBL-PrBL compared to didactic lecture and it should be included in

pathology module, these two items received the lowest mean scores, 3.90±1.20 and 3.98±1.21 respectively. For all the 10 items, there were no significant differences among male and female respondents. Additionally, when comparing bumiputra and non-bumiputra, there was no significant differences in their responses.

Likert scale was employed and students were required to give their opinion on each item in the questionnaire based on the 5 scales and scores (Strongly disagree (1 score), Disagree (2 scores), Neutral (3 scores), Agree (4 scores), Strongly agree (5 scores)). In the data tabulation, the two extreme scales (strongly disagree and strongly agree) were combined with the adjacent scales (disagree and agree respectively) for conciseness. Item 1: assessed students' team working skills, Items 2 and 3 assessed students' motivation, Items 4 to 8 assessed students' subject-specific understanding, Items 9 and 10 assessed students' satisfaction towards this method.

DISCUSSION

To the best of our knowledge, this is the first study that adapts the combination of team-based learning (TBL) and project based learning (PrBL) in a single teaching-learning session. Based on the results, the combination of TBL-PrBL helped students understand the subject matter and improved their teamwork skills and motivation.

Teamwork skills and motivation to learn

TBL-PrBL teaching-learning method integrates other learning domains to optimize student engagement.[24,25] Analysis of the data revealed strong agreement among students on the improvement of their teamwork skills (Item 1) and the motivation for them to learn pathology through this approach (Item 2). Through group discussions, the students learn cooperative problem-solving in the TBL and actively contribute and exchange ideas that were essential for the creation of models in the PrBL session. As a result, these interactive dynamics enhanced the learning process by fostering affective domain level 2 (responding) and psychomotor level 3 (guided response) competencies which further enriched their learning experience.[26]

Table 1: Students' perception on combined Team-Based Learning – Project-Based Learning for single Pathology module session (n=44).

Item	Questions	Score Mean ± SD	Categories	Participants n (%)	Male n (%)	Female n (%)	P-value*	Bumiputra n (%)	Non-Bumiputra n (%)	P-value*
1	It helps to improve team working skills	4.25 ±1.08	Disagree	3 (6.8)	1 (5.3)	2 (8.0)	0.874	3 (9.1)	0 (0.0)	0.720
			Neutral	9 (20.5)	3 (15.8)	6 (24.0)		6 (18.2)	3 (27.3)	
			Agree	32 (72.7)	15 (78.9)	17 (68.0)		24 (72.7)	8 (72.7)	
2	It motivates me to learn Pathology	4.16 ±1.12	Disagree	4 (9.1)	2 (10.5)	2 (8.0)	0.379	4 (12.1)	0 (0.0)	0.547
			Neutral	9 (20.5)	2 (10.5)	7 (28.0)		6 (18.2)	3 (27.3)	
			Agree	31 (70.5)	15 (78.9)	16 (64.0)		23 (69.7)	8 (72.7)	
3	TBL stimulates my thinking	4.20 ±1.07	Disagree	3 (6.8)	1 (5.3)	2 (8.0)	0.874	3 (9.1)	0 (0.0)	0.720
4	TBL improve my reasoning skills	4.18 ±1.08	Disagree	3(6.8)	1 (5.3)	2 (8.0)	0.679	3 (9.1)	0 (0.0)	0.861
			Neutral	10 (22.7)	3 (15.8)	7 (28.0)		7 (21.2)	3 (27.3)	
			Agree	31 (70.5)	15 (78.9)	16 (64.0)		23 (69.7)	8 (72.7)	
5	It promotes better understanding of the subject matter.	4.27 ±1.11	Disagree	3(6.8)	1 (5.3)	2 (8.0)	0.679	3 (9.1)	0 (0.0)	0.861
			Neutral	10 (22.7)	3 (15.8)	7 (28.0)		7 (21.2)	3 (27.3)	
			Agree	31 (70.5)	15 (78.9)	16 (64.0)		23 (69.7)	8 (72.7)	
6	TBL help to reduce my misconceptions about the topic.	4.11 ±1.15	Disagree	4 (9.1)	2 (10.5)	2 (8.0)	0.505	4 (12.1)	0 (0.0)	0.743
			Neutral	11 (25.0)	3 (15.8)	8 (32.0)		8 (24.2)	3 (27.3)	
			Agree	29 (65.9)	14 (73.7)	15 (60.0)		21 (63.3)	8 (72.7)	
7	This type of teaching helps me to relate pathological principles to real life situation.	4.20 ±1.07	Disagree	3 (6.8)	0 (0.0)	3 (6.8)	0.441	3 (9.1)	0 (0.0)	0.720
			Neutral	9 (20.5)	4 (21.1)	5 (20.0)		6 (18.2)	3 (27.3)	
			Agree	32 (72.7)	15 (78.9)	17 (68.0)		24 (72.7)	8 (72.7)	
8	It helps to gain an in-depth knowledge about the subject.	4.09 ±1.18	Disagree	6 (13.6)	3 (15.8)	3 (12.0)	0.799	6 (18.2)	0 (0.0)	0.198
			Neutral	7 (15.9)	2 (10.5)	5 (20.0)		4 (12.1)	3 (27.3)	
			Agree	31 (59.1)	14 (73.7)	17 (68.0)		23 (69.7)	8 (72.7)	
9	I prefer this type of teaching to didactic lectures.	3.90 ±1.20	Disagree	6 (13.6)	3 (15.8)	3 (12.0)	0.096	6 (18.2)	0 (0.0)	0.469
			Neutral	12 (27.3)	2 (10.5)	10 (40.0)		9 (27.3)	3 (27.3)	
			Agree	26 (59.1)	14 (73.7)	12 (48.0)		18 (54.5)	8 (72.7)	
10	I feel that this method should be included in pathology curriculum	3.98 ±1.21	Disagree	5 (11.4)	3 (15.8)	2 (8.0)	0.150	5 (15.2)	0 (0.0)	0.514
			Neutral	11 (25.0)	2 (10.5)	9 (36.0)		8 (24.2)	3 (27.3)	
			Agree	28 (63.6)	14 (73.7)	14 (56.0)		20 (60.6)	8 (72.7)	

Comprehension of the subject matter

It is evident that majority of students strongly agreed that the TBL-PrBL session promoted better comprehension and understanding of the subject matter. TBL served to facilitate students' comprehension of the subject matter through active engagement with questions, whereas the PrBL component further enhanced their understanding by producing an output reflective of their comprehension of the topic.[2,11] This multi-faceted pedagogical approach effectively catered to various cognitive levels outlined in Bloom's Taxonomy. The questions provided during the Individual Readiness Assurance Test (IRAT) and Group Readiness Assurance Test (GRAT) of TBL targeted the cognitive levels 1-2 of Bloom's Taxonomy, whereas the PrBL component primarily addresses levels 2-3, demanding students to comprehend the questions provided before applying their responses into mind maps or infographics as part of the project.[19] Higher-order thinking skills are essential for medical students to acquire as they equip them with the aptitude to make sound decisions, which is a critical skill in the medical field and domain.[24]

Students' satisfaction

Though the responses were generally positive, a small proportion (13.6%) of students did not prefer TBL-PrBL approach over didactic lectures and that the teaching-learning method should not be included in the pathology module (11.4%). This outcome could be attributed to the lack of familiarity with a newly introduced teaching-learning method especially when students have developed convenience towards lecture-based learning method.[27,28] These findings echoed Haidet et al. (2012) and Carrasco et al. (2019) as they reported a lack of preference and motivation of students towards TBL particularly in the early phase of transition from the traditional lecture-based method in the medical curriculum.[5,27] It is postulated that unfamiliarity with the teaching-learning methods coupled with uncertainties on how these sessions may influence their performance in final examinations, contributed to their preference for traditional didactic lectures over the newly introduced student-centred learning technique.[23] The incorporation of a blended approach combining TBL and PrBL aimed to address certain limitations imposed in the conventional TBL methodology. As students' collaboration and involvement in the second half of the TBL was not always consistent,[9,19] transitioning from a thematic question-answering approach in TBL to a more innovative model creation process can break the monotonous approach in TBL and maintain their interest and curiosity throughout the session.[19] However, it is ascertained that this pilot study on students' perception does not provide a solid assessment on the effectiveness of TBL and combined TBL-PrBL method with the didactic lecture-based approach.

Limitations

There are several limitations in this study that need to be addressed. This is a cross-sectional pilot study with small sample size, therefore the comparison between the traditional TBL with this combined TBL-PrBL method cannot be adequately assessed. This study evaluated students' perception based on a single TBL topic, therefore we cannot explore the potential of other confounding factors that could influence students' perceptions. This comprises the choice of topic, the difficulty level of the subject matter and the facilitator in charge. This combined method's limitation also include the challenge that the students face in adhering to the allocated timeframe for completing the model construction.

Future directions

As the combined TBL-PrBL approach is still new, we believe there are areas that can be further explored and improved in its implementation within the medical curriculum. Future studies could look into the perception of TBL in various topics, disciplines, different facilitators, larger sample size in a case-control study. To augment the practicality of this method, a short and simple project assigned earlier with instruction provided during preparative phase could be the way forward.

CONCLUSION

In conclusion, this study highlights the potential of TBL-PrBL approach to address the evolving demands of 21st-century learning skills. By bridging the gap of conventional TBL methods, this hybrid model offers a

potential role in enhancing student engagement and critical thinking. Looking ahead, we believe that further refinement and integration of TBL-PrBL methodologies into medical curriculum could lead to significant advancements in medical education and potentially extended to broader applications in higher education settings.

ETHICAL APPROVAL

Ethical approval for this study was granted by the UPNM Research Ethics Committee (Ethics No.: UPNM (FPKP) 14.01/02).

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