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Validation of the Instruments Measuring Team-based Learning Strategy

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Abstract

The main objective of this study is to analyse the reliability and validity of psychometric properties of two instruments: Team-Based Learning Student Assessment Instrument (TBL-SAI) and the Team Performance Survey (TPS). A 33-item TBL-SAI and an 18-item TPS were administered to investigate undergraduate students' perception of TBL and PBL incorporated in the medical terminology course were recruited. A Cronbach's alpha test and a principal component analysis were administered in establishing the reliability and validity of the instruments. The study's results showed that Cronbach's alpha values were 0.88 (TBL-SAI) and 0.98 (TPS), indicating high levels of reliability of both instruments. PCA also discovered that the TBL-SAI scale extracted nine components with all items' factor loading greater than 0.60, except for the first and second items in the accountability domain, and the third item in the learning preference domain. Meanwhile, the TPS scale extracted one component with all items loaded more than 0.6, suggesting both TBL-SAI and TPS scales were appraising the factors intended to be measured. Both TBL-SAI and TPS demonstrated acceptable levels of internal consistency and construct validity in assessing students' perception of TBL and PBL in the course.

Keywords: Active Learning, Team-Based Learning, Problem-Based Learning, Curriculum, Malaysia

Introduction

Problem-based learning (PBL), which was first implemented over half a century ago, has been acknowledged as a keystone of learning methods in several medical education curricula worldwide (Karimi, 2011; Yew & Goh, 2016). PBL is characterised as a student-centred learning technique that includes groups of students collaborating in solving real-world problems instead of traditional teaching methods. PBL is also a set of problem-based and group-centred learning strategies in developing effective learning situations for students. Contrasting traditional lectures, PBL allows students to learn individually, instead of relying on conventional instructional methodology. For instance, group discussion could facilitate the process of enhancing students' levels of comprehension, developing the skills in overcoming various problems, and promoting independent thinking (Alrahlah, 2016). Essentially, the

fundamental of PBL is to create a conducive environment for effective team communication in directing students' learning process.

When applying PBL, educators will explain the facts and ideas regarding a topic to students, before assigning a task for them to complete in their respective groups. With the required background knowledge, students' abilities and skills, including critical thinking, problem-solving, self-reliant learning, adaptability, communication, interpersonal skills, and teamwork are all enhanced by the PBL approach when they are generating notions to the task assigned to them (Meister, 2020). Besides, incorporating e-learning materials into the PBL technique could improve learners' comprehension levels Syahfutra (2019); Kassymova et al (2020), and it is also imperative to adjust the difficulty of the learning materials that suit students' skills in brainstorming relevant solutions to solve an actual problem based on the learned theories or concepts. As such, PBL is effective in training students, especially in developing their innovative and critical thinking skills that act as a preparation for the students when encountering their future challenges and obstacles in daily lives. Furthermore, due to the inherent flexibility, PBL can be implemented together with different teaching methods, such as seminars, assessments, role-play, teamwork, etc (Kassymova et al., 2020).

PBL has been the subject of the long-running debate on the advantages and limitations of the application. Recently, due to the resetting of community norms by the COVID-19 pandemic, adequate opportunities are provided for PBL to serve as a tool in generating solutions to various academic fields. There is a consensus amongst researchers from various areas of expertise for the PBL technique to be implemented in different educational settings before evaluating the effectiveness (Chan, 2013; Galford, Hawkins & Hertweck, 2015; Mergendoller et al., 2006; Strobel & van Barneveld, 2009). For example, the incorporation of PBL in case-based learning in medical education was found to not only improve the clinical skills of medical students but also the medical residents' (Zhao & Wang, 2020). Similarly, PBL was also shown to enhance the visualisation skills of engineering students as the problem-solving skills derived from the technique helped the students in translating the engineering drawings precisely into actual edifices (Ariffin et al., 2020). Moreover, by conducting a systematic analysis, Suparman et al (2021) discovered that there were substantial positive effects of PBL in refining students' problem-solving skills in the mathematic subject after the implementation in Indonesia, compared with their counterparts who adopted the conventional learning methods.

Another pedagogical approach that adopts blended learning is team-based learning (TBL). There is an increasing application of TBL, especially in the healthcare and medical disciplines as it is also considered an alternative approach to PBL. TBL is defined as a student-centred learning technique that provides sufficient opportunities for students in applying their knowledge to solve applied problems through a series of activities in a small group with their peers, including individual work, teamwork, and team collaboration (Goh et al., 2020; Huang et al., 2016; Parmelee et al., 2012; Santana et al., 2019). As such, a learning environment in a smaller group is more conducive to increasing students' levels of involvement, in-depth comprehension of principles, and awareness of personal obligations towards group members during the learning process (Bergess et al., 2020; Burgess et al., 2014; Bergess et al., 2015, Bergess et al., 2016)

Accordingly, the TBL approach was first introduced to second-year students who were majoring in the Health Management programme and taking the medical terminology course at Universiti Teknologi MARA (UiTM) Selangor in 2019. During the semester, TBL was instituted as an alternative for traditional lectures to improve student performance due to

their achievement of moderate to poor scores in the continuous assessment and the final examination (Azizam et al., 2020). Concurrently, as the contents of the module are currently inspected thoroughly, PBL is also introduced and aimed to provide a key foundation in facilitating higher-order thinking amongst students. PBL allows students to learn individually through group engagement in solving case studies related to the module contents, and facilitators support the students in achieving the instructional goals and improving their abilities. This method is anticipated to prepare and equip students with sufficient problem-solving skills for the subsequent semester when they enrol in the medical coding course requiring them to assign codes for different clinical case studies. Therefore, problem-solving skills are critical for students to accurately identify principal diagnoses and assign the codes correctly for a wide variety of conditions in the module.

In addition, PBL is a highly innovative learning technique implemented by various Asian universities, especially in the healthcare and medical fields (Sun et al., 2018). However, the majority of educators from Asian countries faced challenges in implementing PBL and TBL as most Asian students rarely collaborated with their peers in the learning activities and there was a limited engagement of students in the self-directed learning process (Shimizu et al., 2019). As such, the objective of this study is:

- to assess the reliability and validity of the Team-Based Learning Student Assessment Instrument (TBL-SAI) and Team Performance Survey (TPS) in measuring Health Administration students' perception of the TBL and PBL application in the medical terminology course.

-

The study was conducted through the three research questions (RQs) as below:

- RQ1: Is the TBL-SAI reliable and valid in assessing students' perception of TBL application in teaching the medical terminology course?
- RQ2: Is the TPS reliable and valid in measuring students' perception of PBL application in teaching the medical terminology course?
- RQ3: Is there a significant difference in students' perception of TBL and PBL application?

Materials and Methods

Participants

This study was cross-sectional research involving all students from the Health Administration programme in the Faculty of Business and Management (FBM) at Puncak Alam Campus, UiTM Selangor, taking a medical terminology course during the semester from March to August 2021. Starting March 2021, 87 Health Administration students took the course and participated in the TBL and PBL sessions as part of their required continuous assessment. These students were randomly assigned into three groups: Group A, Group B, and Group C.

Contents of PBL and TBL Sessions

PBL and TBL techniques were implemented in the medical terminology curriculum after receiving approval from the FBM. The medical terminology course provides an overview of the fundamental rules in utilising the components of medical terminology wherein students can build and translate different technical jargon. The course also aims to assist students in

comprehending and applying medical terminology within the context of anatomy and physiology of the human body systems. In the course, the terminology part includes a brief introduction of medical components – word roots, prefixes, combining forms, and suffixes required to establish medical terms. Besides, the course consists of ten modules, namely (1) Introduction to Medical terminology, (2) Musculoskeletal System, (3) Cardiovascular System, (4) Respiratory System, (5) Digestive System, (6) Urinary System, (7) Nervous System, (8) Special Senses: The Eye and Ear, (9) Integumentary System, and (10) Reproductive System. The course learning outcomes (CLO) for students are 1) to demonstrate the ability to build and translate the medical terminology, and 2) to describe the anatomy and physiology of the human body systems. The items of the research instruments designed for both PBL and TBL approaches were consistent with the CLOs of the course.

Structure of TBL Intervention

The TBL intervention was conducted for three hours per week, covering four chapters (Musculoskeletal System, Cardiovascular System, Respiratory System, and Digestive System) of the medical terminology course. Each TBL group consisted of a maximum of five students and the steps of the TBL approach were implemented as per those of Azizam et al (2020) with two modifications on the timing and contents respectively. Firstly, students in each group were not given any reading materials for pre-class preparation. Secondly, the Individual Readiness Assurance Test (IRAT) that was part of the TBL intervention was not conducted. Instead, students were instructed to equip themselves with the necessary knowledge on the topics one week before the intervention took place.

Structure of PBL Intervention

The PBL intervention was conducted for three hours per week that comprised five chapters (Digestive System, Urinary System, Special Senses, and Reproductive System) by replacing the traditional lectures that would normally occur. Each PBL group consisted of a maximum of eight students, and they were informed to discuss with their team members in completing all the questions given for each chapter. One week before the implementation of the intervention, students were instructed to prepare themselves with the required knowledge on the topics.

Research Instruments

TBL-SAI was employed to evaluate students' perception of TBL implementation in the course. TBL-SAI comprises 33 items of three domains anchored in a five-point Likert scale. Domain 1 consists of eight items that assess accountability, Domain 2 with fifteen items that evaluate students' learning preferences, and Domain 3 contains ten items that measure student satisfaction (Mennenga et al., 2012). An 18-item TPS was also utilised to gauge students' perception of the PBL approach incorporated in the course. Each item was measured on a seven-point response scale, ranging from 0 as "None of the Time" to 7 as "All of the Time" (Thompson et al., 2009). In the current study, the response scale was modified to range from "Strongly Disagree" to "Strongly Agree" apropos of the scale employed by (Bergess et al., 2017).

Statistical Analyses

Collected data were analysed by administering the statistical software – Statistical Package for the Social Sciences (SPSS) version 25.0. Descriptive statistical analyses were

conducted to provide simple summaries and the basic characteristics of the sample in the formats of mean and standard deviation. The Kaiser-Meyer-Olkin (KMO) test was also administered to determine the sampling adequacy and values greater than 0.6 resulted from the test would be considered adequate for factor analyses to be conducted for the instruments subsequently (Nation et al., 2016). A principal component analysis (PCA) with direct oblimin rotation was then performed to extract the components from both TBL-SAI and TPS respectively, and the validity of the instruments would be determined when the items with factor loading greater than 0.6 were established. Furthermore, the reliability of the instruments was examined by conducting Cronbach's alpha test. Analysis of variance (ANOVA) was also administered to gauge the difference in the perceptions of TBL and PBL approaches implemented in the course between the three groups of students. Findings with p-values smaller than 0.05 would be considered significant.

Ethics Approval

The TBL-SAI and TPS were distributed to all Health Administration students who took the medical terminology course during the semester from March until August 2021. Permission was requested and acquired from the researcher Heidi Mennenga before employing the instruments. The ethics approval was also obtained from the ethics committee of the FBM before implementing both TBL and PBL approaches in the course. Moreover, the written consent for participation with the outline of the objectives of both interventions was obtained from the students who were willing to participate in the study.

Results

The PCA with direct oblimin rotation was executed and items with factor loading larger than 0.6 from the TBL-SAI and TPS were employed for the study (Hair et al., 2009). Before administering the PCA, a normality test was conducted for both instruments as the normal distribution of the data was a prerequisite before proceeding with further data analyses (Anon, 2005). Data from the TBL-SAI were discovered to be normally distributed after conducting the Kolmogorov-Smirnov test as the findings showed that the p-value was greater than 0.05. On the other hand, data from the TPS was transformed into normal distribution by applying the inverse distribution method.

KMO Test

The data were then subjected to the KMO test to determine the sampling adequacy wherein items with factor loading greater than 0.60 were required to be achieved before performing the PCA (Tabachnick, 2008). The KMO test discovered that the sampling adequacy achieved a satisfactory level with 0.77 and 0.93 for both TBL-SAI and TPS respectively (as shown in Table 1), thus allowing the PCA to be conducted subsequently.

Table 1
KMO and Bartlett's Test for TBL-SAI and TPS

Kaiser-Meyer-Olkin Measure of Sampling Adequacy		TBL-SAI	TPS
		0.77	0.93
Bartlett's Test of Sphericity	Approx. Chi-Square df	1,688.10 528	1,693.80 153

Sig. < .001 < .001

The PCA extracted in total nine components for the TBL-SAI with a total variance of 72.24% explained by the items. Of all 32 items of TBL-SAI, a total of four items loaded less than 0.40 (as shown in Table 2 and Table 3). Meanwhile, one component with a total variance of 76.26% was identified for the TPS. All TPS items had a factor loading greater than 0.6 (as demonstrated in Table 2 and Table 4). Cronbach's alpha test was also performed, and the results showed that both TBL-SAI and TPS achieved high levels of reliability with the values of 0.88 and 0.98 respectively.

Table 2

Variance Explained by the Components in TBL-SAI and TPS

Tool	Component	Extraction Sums of Squared Loadings		
		Total	% of Variance	Cumulative %
TBL-SAI	1	9.59	29.05	29.05
	2	3.31	10.02	39.07
	3	2.60	7.88	46.96
	4	1.95	5.90	52.85
	5	1.74	5.28	58.13
	6	1.37	4.15	62.28
	7	1.17	3.55	65.83
	8	1.10	3.32	69.15
	9	1.02	3.10	72.24
TPS	1	12.55	73.84	76.26

The ability of TPS and TBL-SAI to distinguish the difference in students' perception of the implementation of the PBL and TBL approaches between the three groups of students was also assessed. ANOVA was conducted and the findings indicated that there was a significant difference in the TPS scores and preference domain between the groups ($p < .001$). Table 5 shows the descriptive statistics of the variables.

Table 3

Factor Loading of the Items of TBL-SAI

Component	Item	
	I study before class to be more prepared	.806
	I feel I have to prepare for this class to do well	.822
	I contribute to my team member's learning	.742
	My contribution to the team is not important	.640
	My team members expect me to assist them in their learning	.723
	I am accountable for my team's learning	.693
	I am proud of my ability to assist my team in their learning	.874
	I need to contribute to my team's learning	.874

Component	
Item	
During the traditional lecture, I often find myself thinking of non-related things	.660
I am easily distracted during a traditional lecture	
I am easily distracted during team-based learning activities	.735
I am more likely to fall asleep during lectures than during classes that use team-based learning activities	
I get bored during team-based learning activities	.723
I talk about non-related things during team-based learning activities	.669
I easily remember what I learn when working in a team	.673
I remember material better when the instructor lectures about it	.734
Team-based learning activities help me to recall past information	.693
It is easier to study for tests when the instructor lectured over the material	.741
I remember information longer when I got over it with my team members during group assurance test (GRAT) used in team-based learning	.724
I remember material better after application exercises used in team-based learning	.844
I can easily remember material from the lecture	.672
After working with my team members, I find it difficult to remember what we talked about during class	.746
I do better on exams when we used team-based learning to cover the material	.888
After listening to a lecture, I find it difficult to remember what the instructor talked about during class	.797
I enjoy team-based learning activities	.743
I learn better in a team setting	.710
I think team-based learning activities are an effective approach to learning	.772

Table 4

Factor Loading of the Items of TPS

Item	Component
All team members made an effort to participate in discussions	0.92
When team members had different opinions, each member explained his or her point of view	0.92
Team members encouraged one another to express their opinions and thoughts	.080
Team members shared and received criticism without making it personal.	0.91
Different points of view were respected by team members	.867
Often members helped a fellow team member to be understood by paraphrasing what he or she was saying	0.90
My team used several techniques for problem-solving (such as brainstorming) with each team member presenting his or her best ideas	0.90
Team members worked to come up with solutions that satisfied all members.	0.84
All team members consistently paid attention during group discussions	0.85
My team actively elicited multiple points of view before deciding on a final answer	0.89
Team members listened to each other when someone expressed concern about an individual or team performance	0.92
Team members willingly participated in all relevant aspects of the team	0.89
Team members resolved differences of opinion by openly speaking their minds	0.74
Team members used feedback about an individual or team performance to help the team be more effective	0.81
Team members seemed attentive to what other team members were saying when they spoke	.885
My team resolved many conflicts by compromising between team members, with each one giving in a little	0.85
	0.91

Table 5

Descriptive Statistics of TBL-SAI and TPS

Instrument	Mean (SD)
TBL-SAI	
Accountability	31.73 (0.32)
Learning Preference	53.65 (0.55) *
Student Satisfaction	39.58 (0.55)
Total Score	124.97 (10.48)
TPS	76.32 (10.94) *

*ANOVA, significant at $p < 0.05$

Discussion

The main objective of this study is to analyse and determine the validity and reliability of the TBL-SAI and TPS in measuring students' perception of TBL and PBL application in the course. TBL and PBL have gradually become important teaching approaches in healthcare and medical curricula (Burgess et al., 2020; Ibrahim & Sleem, 2019), namely the fields of nursing (Alberti et al., 2021; Burton et al., 2021), pharmacy (Nation, 2016; Tweddell et al., 2020), and health management (Azizam et al., 2019) in recent years. Simultaneously, UiTM has been highly encouraging innovative delivery methods in teaching and assessments, such as online learning, blended learning, and PBL. However, there is limited research on the effectiveness of TBL and PBL implementation in UiTM. To the best of the author's knowledge, the current study is the first in identifying the validity and reliability of the two instruments – TBL-SAI and TPS that are commonly adopted to assess the perception of incorporating TBL and PBL in the medical terminology module amongst the students from the Health Administration programme of the FBM at UiTM. Given the growing acceptance of TBL and PBL in medical and allied health education, employing a validated instrument in evaluating the effectiveness of the aforementioned approaches is crucial in gauging students' learning preferences in their study.

In general, the findings indicated high levels of reliability and validity that supported the generalisability of the TBL-SAI in measuring students' perception of TBL implementation in the course. In addition, the findings were also consistent with previous studies that the TBL-SAI was a valid predictor of students' perception of TBL and a reliable instrument to be adopted in various cultural backgrounds (Nation et al., 2016; Ibrahim & Sleem, 2019). The internal consistency of TBL-SAI total scales was found to be 0.77, and both descriptive statistical analyses and PCA also demonstrated that most items of the TBL-SAI (except four) had a factor loading greater than 0.6, postulating that the TBL-SAI was valid and reliable in measuring students' attitude and perception towards the TBL application in the medical terminology module. Similarly, the TPS also displayed high reliability and construct validity levels as shown by the value of the explained item variance – 76.26%, which was higher than the reference value posited by Thompson and colleagues (2009). In addition, the TPS was able to show a significant difference in the perception scores between different groups of students, corroborating that TPS was capable of measuring PBL application at the group level.

Besides, the mean scores of TBL-SAI and TPS found in this study suggested that the TBL and PBL were highly accepted in the course, provided that most students appreciated and benefited from the two learning approaches. The scores obtained in this study were also reported higher than those of previous studies that gathered from nursing students (Mennenga et al., 2012), medical students (Ibrahim, 2020), pharmacy students (Nation et al., 2016, Sharma et al., 2017), and physical therapy students (Livingston et al., 2014). Due to the impact of the Covid-19 pandemic, the operation of Malaysian educational institutions was halted, and the teaching and learning process was conducted through open and distance learning (ODL). The high score of TBL-SAI found in this study might be due to TBL conducted during ODL wherein students could access learning materials conveniently from a wide variety of online sources. Furthermore, knowledge acquisition before attending classes for TBL and PBL enriched the learning contents during the group discussion (Abdalla, 2014). Students who were more prepared before class rated their team quality highly as the group discussion was improved with the learning approaches.

In addition, the descriptive statistical analysis demonstrated that there was no significant difference in the TBL domains of accountability and student satisfaction (except for learning preference), and the overall score of TBL amongst the student groups. The results

could be explained by the study of Keskin and Yurdugul (2019), wherein they discovered that there was a significant association between the student preferences and the learning settings. As the TBL was conducted in an ODL setting during the data collection stage of this study, students might encounter several issues, including technology literacy, e-learning readiness, online learning experience, communication skills, and isolated classroom environment (Wojciechowski & Palmer, 2005), thus affected their ratings on the learning preferences. Medical terminology is a course that involves students in examining the anatomy and physiology of the human body systems; however, most students of the current study had not taken any relevant science subject, for instance, biology in their previous level of education. Hence, the students might prefer face-to-face lectures to have a deeper understanding of the course contents due to the depths and complexities of the modules.

There was also no significant difference found in the accountability scores between the three groups of students. Accountability is an important domain of TBL as smaller learning settings engender higher levels of responsibility from students in contributing to their groups during the problem-solving activities (Davidson et al., 2014). Furthermore, the results could be partly associated with the similarities in the delivery methods between TBL and PBL, given that the medical terminology course was conducted by the same facilitator. This is because educators are expected to be highly specialised and knowledgeable in their areas of expertise and possess sufficient skills in encouraging students to be actively engaged in the learning process (Hunter, 2008). Nonetheless, the study's findings indicated a significant difference in the team performance scores between the student groups. This could be illustrated by the preparations of students before joining the classes that implemented TBL and PBL, and the scores obtained from the learning approaches contributed to increasing the overall grade marks of the students. Therefore, the preparations before involving in the group discussions and the contribution of students to their respective groups played an important role in influencing the perception and effectiveness of TBL and PBL applications (Levine et al., 2007).

Conclusion

In short, the TBL-SAI and TPS established high levels of internal consistency and construct validity in assessing students' perception of TBL and PBL implementation in the medical terminology course. Based on the scores, TBL and PBL were favoured by students as they acknowledged the benefits garnered from the student-centred learning approaches. Although both instruments were shown to be valid tools in measuring the perception of the health management students on the learning approaches, the applicability of the instruments for all modules of the Health Administration programme should be ascertained before further implementation, depending on whether the findings of the current study would be replicable in future studies in determining the adoption of the appropriate teaching methodology by health management facilitators and educators, for example, TBL and PBL.

The research findings contribute insights to academic programs and instructors concerning student perceptions and attitudes as TBL and PBL are introduced. The TBL-SAI and TPS instrument may be helpful in better understanding students' responses at various TBL and PBL implementation phases, particularly in higher institutions with instructors who are new to TBL and PBL approaches.

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