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Adopting Team-Based Learning for In-Service Teachers: A Case Study

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Abstract
Team-based learning (TBL) is an instructional pedagogy that has gained recent popularity due to its effectiveness in disciplines such as medicine and business. However, TBL has not been widely adopted in teacher education based on reviews of research and practitioner based literature. The purpose of this case study was to assess the implementation and effectiveness of TBL in a Singapore teaching institute with thirty in-service teachers. Quantitative and qualitative data was collected from teachers about their experience learning through TBL. Research findings revealed that 1) teachers generally perceived TBL to be a positive experience, although several areas for improvement were suggested; 2) quality of scores through TBL was high, with team scores being significantly higher than individual scores. The findings from this study have the potential to guide the design of future TBL courses in education.

Keywords
Team-Based Learning, Pedagogy, Teamwork, Teacher Education

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Adopting Team-Based Learning for In-Service Teachers: A Case Study

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INTRODUCTION

Team-Based Learning (TBL) is an instructional approach designed to combine the principles of Problem-Based Learning, Student-Centred Instruction, and Constructivism. Popularized by Larry Michaelsen in the late 1970s, TBL first gained prominence in medical education as a framework to develop intern and resident doctors (McMahon, 2010). TBL has since been adopted throughout health sciences and business curricula, and more recently, in teacher training (Samad, 2015). TBL is a team-based, peer teaching strategy that focuses on fostering positive team dynamics through intra-team communication. TBL provides students with opportunities to expose inconsistencies between their current and new understanding in order to build new knowledge (Samad, 2015; Hrynchak & Betty, 2012). One of the values of TBL is that it can be used as a complete course framework strategy but is versatile enough to be effective when delivered as part of a hybrid design (Michaelsen & Sweet, 2008).

Sequence of Team-Based Learning

A TBL sequence typically consists of three stages. The three stages can take place within a single course meeting or distributed over several sessions. These stages are student preparation, readiness assurance, and application. In the student preparation stage, students are provided learning resources to study individually before the TBL session. Students should review the materials prepared before coming to class. Upon arrival to class, the instructor proceeds with the readiness assurance tests. Students first complete the Individual Readiness Assurance Test (IRAT). The IRAT is a multiple-choice test assessing knowledge gained from the learning resources provided by the instructor. The IRAT is usually comprised of 10-15 questions and students are provided approximately 15 minutes to complete the assessment (McMahon, 2010). During the IRAT, students fill in an assessment form and, concurrently, copy their answers down on a separate document for later retrieval.

Following the IRAT, students proceed with the Team Readiness Assurance Test (TRAT) which takes places as soon as the time limit is up for the IRAT. The TRAT is comprised of the same multiple-choice questions but students complete the TRAT with teammates that have been pre-assigned. Individuals know which answers they provided for the IRAT and can discuss their responses with their teammates. The teams answer questions using a specially design scratch-off answer card. Once the teams complete the TRAT, they are provided an opportunity to appeal any questions they believe to be unfair or ambiguous.

The IRAT and the TRAT are designed to assess student readiness before advancing to the higher level problem-solving required in the application stage. The application stage requires students to apply the knowledge learned in problem-based scenarios. This stage involves intra-team discussion and larger class discussions, with the emphasis on the application of knowledge as opposed to simple rote learning. Application exercises (AE) are provided during this stage which focus on students working together to solve a common problem. For example, if the unit is focused on learning more about social media, the IRAT and TRAT may cover definitions, types of social media, and statistics about the use of social media today. The application exercises may have students come up with creative ways to use social media in a classroom, business, or specific industry.

Principles of Team-Based Learning

In McMahon’s (2010) analysis of TBL, he states four essential principles. The first principle is team formation and maintenance. Teams should be formed at the beginning of the course and members should stay together throughout the course. Instructors should be deliberate and thoughtful in team formation and ensure that members come from different knowledge base and backgrounds. The process of groups actualizing into efficient teams may be bumpy and require maintenance but this process should be worked out by the members themselves without much intervention from the instructor. This allows students to learn to work with each other instead of relying on themselves as individuals.

The second principle is that all students should be accountable for their contribution to the team. This crucial because students learn best when there is an immediate need and an appropriate incentive (McMahon, 2010). TBL holds students accountable through their individual grades and their contributions to the team score. To increase accountability, peer evaluation can also be strategically incorporated into parts of the course. A key to effective peer evaluation is facilitating a frank discussion with honest, constructive criticism given. Instructors should ensure that students understand the importance of honest peer evaluation by team members.

The third principle of TBL is the provision of real-time feedback to students. This is implemented through the use of scratch-off
answer cards during TRAT, where answers will signal to teams whether their interpretation of the concept was correct. Real-time feedback during the practice rounds helps enhance student learning and reinforces student learning by addressing small increments of the overall learning objectives. Corrections to misconceptions can be offered immediately by peers or the instructor to strengthen learned knowledge.

The fourth principle stated by McMahon (2010) is that team assignments in the application phase should promote both student learning and teamwork. Thus, assignment grades and AE should be designed to require team interaction. This covers an important aspect of TBL—peer teaching. The assignment should not be able to be broken into individual assignments with each student covering one assignment; it is the peer teaching that drives team formation.

### Background for the study

The majority of the research on the effectiveness of TBL has been conducted in medical and business contexts. For example, Rainie et al. (2011) examined 137 students’ attitudes and satisfaction towards a TBL course in upper division accounting. The authors found that students generally responded positively and recognised its benefits to develop teamwork skills. A similar study was conducted by Chad (2012) who examined the first time use of TBL in a postgraduate marketing module in an Australian university. The author found that TBL had a positive influence on student engagement and offered opportunities for assisted learning. In a more rigorous study, Vasan et al. (2011) ran a longitudinal 5-year study comparing student performance of a TBL-based pre-clinical course and its control. The study found that student performance was not only higher in the TBL-based course but students also perceived TBL as a motivating tool for teamwork learning. Similarly, these studies support that researchers have demonstrated that TBL is an effective teaching method enabling educators to offer students a more enhanced and stimulating learning experience.

Most recent reports of a longitudinal study of medical students taught using TBL was conducted by Zghaib et al. (2016). Based on a new curriculum, 90 TBL sessions were implemented in 2 years to 102 medical students to evaluate the long-term impact of TBL. The authors found sustained and cumulative improvement in teamwork and communication skills, professional, and personal development over time. This was the first study to demonstrate the long-term impact of TBL. Research has also branched out into evaluating modified TBL classes, which retain core elements of TBL but incorporates other aspects of pedagogy that may be more suitable for its target audience. One such study was conducted to examine the impact of a modified TBL. Research has also branched out into evaluating modified TBL in an Ophthalmology Clerkship in China. The one-week clerkship included traditional lectures, gross anatomy, and a TBL module. The results revealed that 57.65% of students agreed that modified TBL was helpful. In the modified TBL study, students were divided into their pre-assigned groups. The age range of the teachers in the class was 24 to 59 years old, although the majority of the teachers were between 30 to 39 years old. Teachers were selectively pre-grouped into teams of five or six. Teachers were grouped into teams according to content area taught, gender, and ethnicity. The course was divided into four themes of technology use: (1) The Reality of Mobile Technology, (2) Communication and Connection, (3) Content Curiosity, and (4) Assessment. Each theme took place for three weeks of the class with one week left for the introductory session. In the first week of each theme, the IRAT and TRAT were conducted alongside the introduction to the topic. AE would take place in the second and third weeks. The goal of this study was to evaluate the effectiveness of implementing TBL in a Singaporean context through teachers' course performance and their individual perceptions of the TBL experience.

### Grading Process

The grading process for the four themes had two parts: the first part had five components. These were: (1) evidence of using important mobile tools (e.g. polling software, backchannel discussions, etc.), (2) IRAT score, (3) TRAT score, (4) AE score, and (5) individual blog developed by teachers showcasing their learning in the course. The grading process was designed to consist of a mix of both TBL and non-TBL assessments. Originally, a ranking system was introduced to assess peer evaluation but was modified in consideration of teacher response.

The “Ten Tools to Know”, which accounted for 20% of the overall grade, are ten tools that every educator should know about mobile tools and be able to use in class. The teacher’s individual blog, which accounted for 20% of the overall grade, required them to describe a personal plan to implement technology into their teaching and learning environment. The remaining 60% was dedicated to TBL assignments.

### Procedure

On the first day of the course, teachers were given an introductory talk on TBL by an external TBL facilitator. The facilitator was one of the co-founders of the TBL initiatives in Singapore and has conducted several TBL boot camps in and out of the institute. The facilitator briefed teachers on the elements of TBL benefits, and results from previous studies. After the introduction, teachers were divided into their pre-assigned groups.

### Results

Before each of the four themes, teachers were provided a link to access the learning resources for that theme in order to prepare for IRAT and TRAT. These resources included journal articles, website articles, blog pages, and online videos. The IRAT comprised of 10 to 15 multiple-choice questions (MCQs) which teachers had to complete individually. These MCQs were based on the learning resources provided. Questions were derived from the learning resources listed in Table 1. Google Forms was used to administer all the IRAT and Flubaroo was used to grade the TRAT. Teachers were given 15 minutes to complete all questions. Additional time was given to teachers with a documented disability who were given extra time. After the completion of the class, the class was used to mark the start and end of each IRAT. No additional time was given for later-comers.

### Data Collection

Both quantitative and qualitative data were collected to establish comprehensive understanding of the effectiveness of TBL implementation in our course. Quantitative data was collected through the TBL questionnaire which comprised of a demographics section and close-ended questions asking about teachers’ experience of TBL. The demographics section consisted of six items asking teachers on their gender, area of teaching, age, ethnicity, years of teaching, and number of technology courses taken. The body of the TBL questionnaire consisted of questions asking teachers about their TBL experience. Statements were developed from a review of the literature with several being adapted from validated questionnaire surveys used in other studies (Frame et al., 2015). An example of
the statement was, “The use of TBL enhanced my learning experience in class”. The statements were presented in a 5-point Likert scale format with a response ranging from 1 very strongly agree to a statement, and a response of 1 being very strongly disagreement. The questionnaire was peer-reviewed by the TBL facilitator who had designed TBL questionnaires in previous courses.

To collect more detailed responses from teachers, a focus group interview was conducted after the completion of all TBL activities. One teacher was randomly selected from each team to participate. The interview lasted 60 minutes. Questions were designed to be an extension of the questionnaire statements asking about their TBL experience (See Figure 2). A total of seven questions including “Which part of the TBL did you learn the most” and “What did you like and not like about your experience of TBL” were presented. The interview was facilitated by the external TBL facilitator with an assistant.

Figure 2. Example questions asked during the focus group discussion.

Data analysis and coding
Data was analysed descriptively and comparatively to understand student performance and perceptions towards TBL. To prepare data for comparison, an averaged IRAT score was first computed by taking the mean of teachers’ IRAT across all four IRAT sessions. For teachers who were late and missed one (or more) IRAT and had a valid excuse (e.g. medical certificate), their averaged IRAT would be punctual, as it was brought to attention that all teachers were work, teaching) that would prevent them from being punctual all the time. Teachers also disliked that the ranking system could be unfair to teachers who could fail their module as the most disliked part about TBL. Teachers felt that the ranking system with another form of peer evaluation. Teachers thought that every member had a different contribution to each theme was included, with a higher percentage representing more teachers voicing out on that theme (see Table 4).

The most interesting aspect of TBL was the exchanging of ideas in discussions. Teachers thought that every member had a different interpretation of the questions and that they could apply this interactive pedagogy in their own classrooms. They also enjoyed the burning questions as it provided opportunities to clarify any questions with ambiguous answers.

Teachers commented that the aspects of TBL that were most helpful to their learning was application exercises and team readiness discussions. Teachers liked application exercises because the quality of answers they produced had practical value. Through the intra- and inter-team discussions, teachers were able to remember concepts as they had already discussed them. Overall, what teachers used to describe their overall learning from TBL were: “Engaged”, “Beneficial to my learning”, “Improved my interpersonal and problem solving skills”. Peer ranking of each team members’ contribution emerged as the most disliked part about TBL. Teachers felt that the ranking system could be unfair to teachers who could fail their module because of getting the lowest points and suggested to replace the ranking system with another form of peer evaluation. Another aspect that teachers disliked was the requirement to be punctual for TBL sections, especially the IRAT that first takes place during class. Some teachers expressed dissatisfaction with the need to be punctual, as it was brought to attention that all teachers were part-time students. They had undertaken the module as part of their Masters’ curriculum and had concurrent commitments (e.g. work, teaching) that would prevent them from being punctual all the time. Teachers pointed out that schedules may clash or unforeseen circumstances may arise from their commitments and these events may cause them to be late.

Table 3. Questionnaire statements and the means, percentages, and standard deviations of teachers’ responses.

<table>
<thead>
<tr>
<th>Statement</th>
<th>SD</th>
<th>D</th>
<th>N</th>
<th>A</th>
<th>SA</th>
<th>Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBL was a suitable instructional design for the course.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.03)</td>
<td>5</td>
<td>(16.15)</td>
<td>(4.01) ± 1.01</td>
</tr>
<tr>
<td>The use of TBL enhanced my learning experience in class.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.03)</td>
<td>5</td>
<td>(16.15)</td>
<td>(4.29) ± 0.97</td>
</tr>
<tr>
<td>The use of TBL improved my interpersonal and group interaction skills.</td>
<td>(2.65)</td>
<td>0</td>
<td>(0.03)</td>
<td>4</td>
<td>(12.39)</td>
<td>(4.25) ± 1.06</td>
</tr>
<tr>
<td>The use of TBL increased the extent of my usual classroom participation.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.05)</td>
<td>6</td>
<td>(19.69)</td>
<td>(3.90) ± 1.04</td>
</tr>
<tr>
<td>Learning through small groups improved my understanding of the course content.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.05)</td>
<td>2</td>
<td>(16.31)</td>
<td>(4.35) ± 0.88</td>
</tr>
<tr>
<td>Overall I prefer TBL to traditional lectures.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.03)</td>
<td>5</td>
<td>(16.15)</td>
<td>(4.06) ± 1.16</td>
</tr>
<tr>
<td>I would recommend the use of TBL in future TBL courses.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.05)</td>
<td>6</td>
<td>(19.69)</td>
<td>(4.13) ± 0.79</td>
</tr>
<tr>
<td>Overall I am satisfied with the use of TBL in future TBL courses.</td>
<td>(1.33)</td>
<td>2</td>
<td>(6.05)</td>
<td>6</td>
<td>(19.69)</td>
<td>(4.23) ± 0.96</td>
</tr>
</tbody>
</table>

Note: SD = Strongly Disagree; D = Disagree; N = Neither Agree nor Disagree; A = Agree; SA = Strongly Agree.

DISCUSSION
Comparison of IRAT and TRAT performance revealed that mean IRAT scores were significantly higher than mean TRAT scores by 7.05 points. This result was expected and in line with the theoretical understandings of TBL, which state that TBL provides the depth of understanding that can only come from solving problems in teams that are too complex for any individual effort (Michaelsen & Sweet, 2008). Furthermore, this result is in line with previous studies that have found IRAT scores to be better than IRAT scores (Vasan et al., 2001; Vasan et al., 2001; Vasan et al., 2001) further providing evidence for the use of TBL in the Asian teaching context.

The strongest positive correlation was found between teachers’ TRAT score and their FCG. There was also a positive correlation between IRAT scores and teachers’ FCG, although not as strong as this...
The aspect(s) of the course that teachers found to be most important

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
<th>Percentage of Teachers</th>
<th>Most representative statements for each theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Most interesting</td>
<td>The aspect(s) of the course that teachers found to be the most interesting</td>
<td>50%</td>
<td>- The ideas of discussions is very interesting because we can relate it back to our classrooms teaching as well so it is somewhat very interesting.</td>
</tr>
<tr>
<td>Most helpful</td>
<td>The aspect(s) of the course that teachers found to be most helpful for their overall learning</td>
<td>83%</td>
<td>- Application exercises and team readiness</td>
</tr>
</tbody>
</table>

**Table 4.** The themes, definitions, percentage of teachers who responded, and most representative statements for each theme.

supports the validity of IRAT and TRAT, two core components of TBL for learning. More crucially, the TRAT-FCG correlation reinforces the importance of the ‘team’ in TBL.

Interestingly, AE scores were not significantly correlated to FCG. This result could be attributed to the varied nature of tasks that were set for AE. The AE in this study included, among other items, discussion questions and team readiness. Participants in this study had to be most helpful for the use of TBL, when compared to more traditional and lecture-based pedagogies.

**Most helpful**

- Application exercises and team readiness
- Most helpful
- Most interesting
- Definitions
- To be sharply on point learning all the application because no time students with work commitments, it was inevitable that they would be late for some TBL classes. In our course, the importance of punctuality was reiterated repeatedly based on the justification that time period may disrupt other members who had already started discussions for TRAT. One of the possible solutions for future courses is to rethink the entire implementation of IRAT so that teachers are able to arrive at the quiz if they are late for class. One way can be to introduce an online TBL application where teachers can log on to the application to attempt the IRAT as they are on their way to class.

**CONCLUSION**

In conclusion, TBL should be strongly considered as a pedagogical practice in future teacher training programs. This study achieved more work when teams and enjoyed the accountability that TBL requires. There were concerns about the peer evaluation process and how it could be modified for the future. In addition, the timing of TBL lessons may need to be adapted when teachers are working professionals due to work commitments and punctuality concerns. However, participants overwhelmingly found the process to be enjoyable and worthwhile. In addition, teachers were very confident that TBL was able to contribute positively to the development of the teaching standards expected by the university.

**REFERENCES**


