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

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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.

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 test. 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 study, consisting of learning resources, 

studies of the TBL experience (e.g., Frame et al., 2015; Reinig et al., 2011; Cho et al., 2013; Chad, 2012). In addition to this, there is scant research on the challenges faced by instructors during TBL. In this study, we aim to learn from cases where we analysed both quantitative and qualitative data to get a more comprehensive understanding of TBL implementation.

Another reason to conduct this study was due to past reliance on traditional pedagogies in Singapore. Such pedagogies are predominantly teacher-led and lecture-based. One negative consequence of such pedagogies is that in the traditional classroom environment, students are passive participants (as cited in Singtap, 2010, p. 7). Chihem (2000) reported that the education system in Singapore was heavily based on Spoon-feeding, where the teacher acted as a knowledge dispenser for passive students (Chihem, 2000). While such spoon-feeding used to be common in Singapore, schools have begun to adopt practices that require more active participation and interaction from students. Examples of these include the use of blended learning and flipped classrooms (Yang, 2015; NIE, 2010). Finally, a report on the history and future of TBL in Singapore suggests that TBL promotes and enables students to 

The fourth principle stated by McMahon (2010) is that team accountability and self-directed learning. Collectively, these three principles, along with three principles stated by Marsee and Connolly (2014), support the use of TBL in the classroom and are consistent with TBL being an instructional design method that is scintillating and stimulate learning experience.

Most recent meta-analysis of a longitudinal study of medical students taught using TBL was conducted by Zgeheb 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 at Singtap University (2010) to examine the impact of using mobile technology for teaching all students regardless of content area, grade level, age, or ability. Course activities and assessments were designed to develop students’ practical skills and understanding of the educational content and how to apply it in real-life situations. These ‘moderated’ TBL sessions have shown promise in improving student learning outcomes and attitudes towards the TBL experience.

Another important aspect of TBL is 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 context. For example, Reing et al. (2011) examined 137 students’ attitudes and satisfaction towards a TBL course in upper division accounting. The authors found that students generally rated 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 Australia 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 with a traditional course. The results found that student performance was not only higher in the TBL-based course but students also perceived TBL to be a motivator for team-based learning. Therefore, these studies and many others have demonstrated that TBL is an effective teaching method enable educators to offer students a more enhanced and stimulating learning experience.

**Method**

Thirty teachers enrolled in a course focused on the practical applications of technology in education (MSE 850 Technology for Educators) at Singtap University. The course was designed to expose teachers to the potential benefits of using mobile technology for teaching all students regardless of content area, grade level, age, or ability. Course activities comprised of team-based learning, where a team was assigned to complete a specific task in the classroom, and individual learning experiences, where each teacher had to complete the tasks independently. The team-based learning tasks were designed to stimulate learning and encourage collaboration among team members. The individual learning tasks were designed to assess each teacher’s understanding and application of the theoretical concepts introduced in the course. The three-hour course was held in the evening on the first day of the course, and teachers were given an introductory lesson to familiarise them with the theoretical underpinnings of technology adaptation and focused on practical solutions for teachers’ personal and professional implementation. The three-hour course was held in the evening on the first day of the course, and teachers were given an introductory lesson to familiarise them with the theoretical underpinnings of technology adaptation and focused on practical solutions for teachers’ personal and professional implementation.

**Team-Based Learning for Teacher Education**

The TRAT commenced immediately after IRAT. For the TRAT, teams at each table worked together to come to an agreement on each question. The TRAT focused on immediate feedback and was assessed using the immediate-feedback assessment procedure (IF-AT), through a self-scoring answer cards (see Figure 1). These cards serve as timely feedback and allows teachers to correct misconceptions immediately. On these cards, members scratch off one of the four options covered with opaque film to search for a star that indicated the correct answer. If the team found the star on their first try, they received full credit score for four points. If not, they would continue scratching until they find the correct answer, but their score would be reduced with each unsuccessful scratch. This allows teams to receive partial credit for incorrect responses (Michaelsen & Sweet, 2008).

**Figure 1. IF-AT scratch card for the teams.**

After the TRAT was completed, the instructor went through each question and gave teams the opportunity to point out any areas for improvement. The purpose of this exercise was to get teams to consider all students needs and discuss on the features of a smartphone that can fulfill those needs. All necessary resources, including flipcharts and markers, were provided.

**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 closed-ended questions asking about teachers’ experience of TBL. The demographics section consists of six items asking teachers on their gender, area of teaching, age, ethnicity, number of years of teaching, and number of technology courses taken. The body of the 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
then checked the degree of consistency across the statements in grouped them into four unique themes. The principle investigator the focus group interview examined the distinct statements and statistics including frequencies, mean scores, percentages, and individual and team performance and to assess the existence of more control for teacher performance. A paired samples t-test three IRAT he/she completed. However, teachers who missed an would have their averaged IRAT computed based on average of the sessions they attended. For example, a teacher who completed score was computed by taking the mean of their IRAT scores for by taking the mean of teachers' IRAT across all four IRAT sessions. Data analysis and coding Example questions asked during the focus group discussion. 1. What did you find interesting in TBL? 2. Which part of TBL did you learn the most? 3. What did you like and not like about your experience of TBL? 4. For each group: give one topic you found difficult to learn? 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 score was computed by taking the mean of their IRAT scores for the sessions they attended. For example, a teacher who completed the first three IRATs but missed the final IRAT due to a valid reason would have their averaged IRAT computed based on average of the three IRAT he/she completed. However, teachers who missed an IRAT without a valid reason, would be given a score of zero for that particular IRAT. These measures were implemented to ensure more control for teacher performance. A paired samples t-test and Pearson correlation was performed to compare between individual and team performance and to assess the existence of linear relationship between each component of TBL. Descriptive statistics including frequencies, mean scores, percentages, and standard deviation were computed from data from the TBL questionnaire. The Statistical Package for the Social Sciences (SPSS version 20.0) was used for all statistical analyses. Focus group responses were transcribed verbatim from the usual classroom interaction. The study found that TBL was a suitable instructional design for the course. The use of TBL enhanced the learning experience in class. The use of TBL improved the inter-personal and group interaction skills. The use of TBL increased the extent of my usual classroom participation. Learning through small teams encouraged me to think critically. The TBL system improved my problem-solving skills. The TBL system increased my understanding of the course content. Overall I prefer TBL to traditional lectures. I would recommend the use of TBL in future courses. Overall I am satisfied with the use of TBL in future courses. Note: SD = Strongly Disagree; D = Disagree; N = Neither Agree nor Disagree; A = Agree; AG = Strongly Agree. DISCUSSION Comparison of IRAT and TRAT performance revealed that mean IRAT scores were significantly higher than mean IRAT scores by 0.705 points. This result was expected and in line with the theoretical underpinnings 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 (Mithas & Sweet, 2008). Furthermore, this result is in line with previous studies that have found TRAT scores to be better than IRAT scores (Vasan et al., 2011; Vasan & Uthayakumar, 2011). Table 3 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.
Table 4. The themes, definitions, percentage of teachers who responded, and most representative comments for each theme.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
<th>Percents of Teachers</th>
<th>Most Representative Comments</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 discussions going on exchanging of ideas, and discussing with group mates is what makes it interesting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The idea of discussions is very interesting because we can relax it back to our classrooms teaching so well as so it is something very interactive.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Application exercises and team readiness</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I really liked the application because no point learning all the theory without knowing how to apply in real life situation. So when the group shared...it was very enlightening.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>We are able to remember most of the (materials) because we already discussed it.</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>A remark that pertains to the didactic of the need to be sharply on time for classes</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>I guess we are uncomfortable with it because as educators we have heard of eradicating motivation versus interest motivation. When you come up with a ranking system, it creates an eradicating motivation for you to contribute, in a sense. Because you’re worried that you will not be contributing enough. Also very uncomfortable with that.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sometimes we are late because of school meetings and all that, so we will miss the IRAT and sometimes the TRAT will join halfway.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>…because we are part-time (students), we will always encounter the timing part…the commitment…</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>…it is not our intention to be late. We did try to justify that we are not full-time students with intentions to be away; we are working adults who were forced to attend meetings.</td>
</tr>
</tbody>
</table>

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, building of a resource repository, and building programs. This caused variation in teachers’ AE scores as a teacher with strong performances in IRAT and TRAT could have scored lower in their AE but still received a high overall grade.

Overall, the implementation of TBL in this in-training teacher education was well-received. In 9 out of the 11 items we asked on teachers’ experience of TBL, there was a mean response of 4 out of the possible 5. Teachers were most satisfied with the peer evaluation component as a method of learning through small teams and would promote and recommend TBL over traditional lectures in future modules. Overall, 87.1% of teachers responded that they were satisfied with the TBL experience. These results provide further support for the use of TBL when compared to more traditional and lecture-based pedagogies. Results from the focus group data supported teachers’ satisfaction that were revealed from the TBL questionnaire. Most teachers praised the unique method of learning through small group discussions as the exchange of ideas and being able to interact with other members made learning very interesting. In addition, teachers commented that learning through TBL was more beneficial for them because they were able to retain more of the learning materials. These comments correspond to the teachers’ high overall individual FCG and the strong positive correlation between TRAT and FES.

Responses from the qualitative analysis enable us to understand which aspects of TBL teachers liked or disliked. Despite liking elements of team learning such as TRAT, burning questions, and application exercises, teachers also pointed out several dislikes. Most teachers viewed peer evaluation through a ranking system. The course utilised a ranking system which was met with unanimous disapproval from teachers. Teachers felt that the ranking system was to some extent unfair and could contribute to certain teachers failing the module if they received the lowest rank.

Overall, the reactions towards peer evaluation in our study highlights another layer of TBL that can be explored. We were posed with the difficult problem of teachers not favouring the way individual accountability was reinforced. The ranking of team-mates as a method of peer evaluation has not received much attention in literature. Typically, peer evaluation in TBL is conducted by having students fill up peer evaluation forms to assess members (Simonsen, S. R., 2014; Moyer et al., 2012). The purpose of using a ranking system in our study was to create differentiation in teacher effort and award teachers who contributed the most. This method of peer evaluation could also prevent students from “gaming” by giving all members the same grade (Sutherland et al., 2013). Due to the unforeseen response, the peer evaluation component was removed from the overall grading criteria. In future courses, other methods of assessing peer evaluation or reaffirming the rationale behind a ranking system could be done to prevent such difficulties from reoccurring.

The other aspect of TBL that teachers did not like was punctuality. The overall sentiment by teachers was that because they were part-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 the integrity and structure of TBL process should be upheld. As the IRAT began at the start of TBL sessions and would only commence for fifteen minutes after the TRAT starts, teachers who were over time that period may disrupt other members who had already started discussing for TRAT. One of the possible solutions for future courses is to rethink the entire implementation of IRAT so that teachers are able to respond to the quiz even 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 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. In this study achieved more when working in 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 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.

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Punctuality

A remark that pertains to the didactic of the need to be sharply on time for classes


New York, NY: Springer.


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