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

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Abstract
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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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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 place 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 in the form of immediate confirmation or correction 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 learning outcomes.

The fourth principle stated by McMahon (2010) is that team assignments in the application phase should promote both student learning and team development. Assignments designed to be peer-taught 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, Reing et al. (2011) examined 137 students’ attitudes and satisfaction towards a TBL course in upper division accounting. The authors found that students generally agreed positively and recognized 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 against a control course. The authors found that student performance was not only higher in the TBL-based course but also perceived TBL to be a motivator for team learning. Recently, these studies have been extended to other contexts, and researchers have demonstrated that TBL is an effective teaching method enabling 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) in the TAFE college in Singapore. The course was designed to use mobile technology for teaching all students regardless of content area, grade level, age, or ability. Course content covered the use of mobile technology in teaching, and how to use mobile technology in practical solutions for teachers’ personal and professional implementation. The three-hour course was held in the evening one day per week for thirteen consecutive weeks and was taught by one teaching assistant. 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 of age. 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 Curation, and (4) Assessment. Each theme took place for three weeks of the class with one week left for the introductory lesson. In the first week of each theme, the IRAT and TRAT were conducted alongside the introduction of the new technology. The teachers were grouped into teams according to content area taught, gender, and ethnicity. AE would take place in the second and third weeks. The goal of this case 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**

Grading was made up of three components. Each of the components was based on 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 teacher should know about mobile tools and be able to use in class. The teachers’ individual blog, which accounted for 20% of the overall grade, required them to describe a personal plan to implement technology into their classroom. 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, research findings, and its long-term positive impact of TBL. Research has also branched in teamwork and communication skills, professional, and personal development of TBL. The authors found sustained and cumulative improvement in teamwork and communication skills, professional, and personal development of TBL.

**Results**

Based on a new curriculum, 90 TBL sessions were implemented in one year. The age range of the teachers in the class was 24 to 59 years old. The teachers were grouped into teams according to content area, grade level, age, or ability. Course activities covered the use of mobile technology in teaching, and how to use mobile technology in practical solutions for teachers’ personal and professional implementation. The three-hour course was held in the evening one day per week for thirteen consecutive weeks and was taught by one teaching assistant. 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 of age. Teachers were selectively pre-grouped into teams of five or six. Teachers were grouped into teams according to content area taught, gender, and ethnicity.

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**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 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 indicating very strong agreement to a statement, and a response of 1 being very strong 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 scores 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 IRATs 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 were 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 deviations were generated based off 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 digital recordings. The research assistant who was not involved in the focus group interview examined the distinct statements and grouped them into four unique themes. The principle investigator then read the transcriptions and created themes in each chapter. After discussion, there was 100% agreement on the statement-theme fit and the consistency of statements within each theme. In the final stage, the research assistant constructed a definition for each theme and selected example statements that were most representative of that theme. The fit between statement and theme format was as well as the definitions were given a final check by the principle investigator. Following a discussion, both the research assistant and principle investigator reached 100% agreement on the statement-theme fit and definition.

RESULTS
Quantitative Analysis
The teacher sample size with an alpha of 0.05 was used to compare the mean performance scores between IRAT (M = 68.72, SD = 31.0) and TRAT (M = 75.78, SD = 14.47) scores throughout the five TBL sessions. On average, TRAT scores were 7.05 points higher than IRAT scores (t(183) = 12.29) than IRAT scores. This difference was statistically significant, t(276) = 2.76, p < .01. Figure 3 shows a bar chart comparing the mean scores between IRAT and TRAT.

To assess the size and direction of the linear relationship between the variables IRAT, TRAT, AE, and Final Course Grade (FCG), a bivariate Pearson’s product-moment correlation coefficient was calculated. There was a strong positive correlation between IRAT and FCG, r(28) = .495, p = .005. There was an even stronger positive correlation between TRAT and FCG, r(28) = .609, p < .001. Interestingly, the relationship between AE and FCG was not significant (see Table 2).

The frequency, percentages of responses to the statements, and the mean response to each statement are displayed in Table 3. The mean scores for the statements generally indicate a positive attitude towards TBL. However, the correlation between IRAT and FCG, although not as strong. This

### Table 2. Correlations between IRAT, TRAT, AE, and FCG.

<table>
<thead>
<tr>
<th>Correlations</th>
<th>IRAT (2-scaled)</th>
<th>TRAT (2-scaled)</th>
<th>AE (2-scaled)</th>
<th>FCG (2-scaled)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson</td>
<td>.488**</td>
<td>.114</td>
<td>.495**</td>
<td></td>
</tr>
<tr>
<td>TRAT (2-scaled)</td>
<td>.006</td>
<td>.548</td>
<td></td>
<td>.050</td>
</tr>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Coefficient</td>
<td>1</td>
<td>.488**</td>
<td>.114</td>
<td>.495**</td>
</tr>
<tr>
<td>TRAT (2-scaled)</td>
<td>.006</td>
<td>.548</td>
<td>.350</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Coefficient</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td>.548</td>
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</tr>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Coefficient</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FCG (2-scaled)</td>
<td></td>
<td></td>
<td></td>
<td>.495**</td>
</tr>
<tr>
<td>N</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Coefficient</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

** Correlation is significant at the .01 level (2-tailed).

### 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 ± std deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBL was a suitable instructional design for the course.</td>
<td>(1.3%)</td>
<td>(1.3%)</td>
<td>5</td>
<td>(16.1%)</td>
<td>11</td>
<td>4.10 ± 1.07</td>
</tr>
<tr>
<td>The use of TBL enhanced my learning experience in class.</td>
<td>(1.3%)</td>
<td>(1.3%)</td>
<td>2</td>
<td>(6.5%)</td>
<td>11</td>
<td>4.29 ± .97</td>
</tr>
<tr>
<td>The course was able to meet its learning objectives.</td>
<td>(2.6%)</td>
<td>(0.0%)</td>
<td>4</td>
<td>(12.9%)</td>
<td>24</td>
<td>4.25 ± 1.06</td>
</tr>
<tr>
<td>The use of TBL improved my interpersonal and group interaction skills.</td>
<td>(3.2%)</td>
<td>(6.5%)</td>
<td>6</td>
<td>(19.4%)</td>
<td>12</td>
<td>3.90 ± 1.04</td>
</tr>
<tr>
<td>The use of TBL increased the extent of my usual classroom participation.</td>
<td>(6.5%)</td>
<td>(6.5%)</td>
<td>14</td>
<td>(45.2%)</td>
<td>12</td>
<td>5.85 ± 1.12</td>
</tr>
<tr>
<td>The TBL activities encouraged me to think critically.</td>
<td>(3.2%)</td>
<td>(6.5%)</td>
<td>6</td>
<td>(19.4%)</td>
<td>12</td>
<td>4.16 ± 1.04</td>
</tr>
<tr>
<td>Learning through small teams improved my understanding of the content course.</td>
<td>(1.3%)</td>
<td>(0.0%)</td>
<td>2</td>
<td>(6.5%)</td>
<td>16</td>
<td>4.35 ± .88</td>
</tr>
<tr>
<td>Overall, I prefer TBL to traditional lectures.</td>
<td>(3.2%)</td>
<td>(6.5%)</td>
<td>5</td>
<td>(16.1%)</td>
<td>13</td>
<td>4.06 ± 1.06</td>
</tr>
<tr>
<td>I would recommend the use of TBL in future courses.</td>
<td>(3.2%)</td>
<td>(6.5%)</td>
<td>7</td>
<td>(23.3%)</td>
<td>12</td>
<td>4.13 ± .97</td>
</tr>
<tr>
<td>Overall, I am satisfied with the TBL experience.</td>
<td>(3.2%)</td>
<td>(6.5%)</td>
<td>7</td>
<td>(23.3%)</td>
<td>12</td>
<td>4.23 ± .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 TRAT scores were significantly higher than mean IRAT scores by 7.05 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 (Mithuelsen & 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., 2001; Fung et al., 2010) 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. This
**Table 4. The themes, definitions, percentage of teachers who responded, and most representative statements for each theme.**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Definition</th>
<th>Percentage 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. The idea of discussions is very interesting because we can relate it back to our classroom teaching as well so it is something very interactive.</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. 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 exhilarating. We are able to remember most of the [materials] because we already discussed it.</td>
</tr>
<tr>
<td>Peer evaluation through ranking</td>
<td>A remark that pertains to the duality of the peer evaluation system</td>
<td>83%</td>
<td>I guess we are uncomfortable with it because as educators we have heard of intrinsic motivation versus extrinsic motivation. When you come up with a ranking system, it creates an extrinsic motivation for you to contribute, in a sense. Because you’re worried that you will not be contributing enough. And I’m very uncomfortable with that.</td>
</tr>
<tr>
<td>Punctuality</td>
<td>A remark that pertains to the duality of the need to be sharply on time for classes</td>
<td>83%</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. …because we are part-time (students), we will always encounter the string part...the commitment. …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 programs, and a resource repository 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 module 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 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. Peer evaluation was 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 unjust and certain teachers feared 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 members 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 (Simonson, S. R., 2014; Moya et al., 2012). The purpose of using a ranking system in our study was to create differentiation in teacher effort and award teachers who contribute 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.