Effects of Team-Based Learning on Fixed Prosthodontic Education in a Japanese School of Dentistry

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Abstract: The aims of this study were to evaluate the quality of team-based learning (TBL) in prosthodontics education for fourth-year dental students at Tokushima University School of Dentistry and to compare this teaching method with traditional lecture-based delivery. Participants in the study were 36 students (22 males and 14 females) who attended the TBL-style fixed prosthodontics course. Ten 60-minute classes were held. The first three were traditional lecture-style classes and were followed by one class introducing the TBL style. The remaining six classes constituted the TBL-format fixed prosthodontics course. The effectiveness of TBL was evaluated through student questionnaires at the end of each class and the results of the term-end examination. The questionnaire revealed high student approval for TBL-style learning, and active group discussion among students during TBL was a key factor in these ratings. In the results of the term-end examination, there were significantly higher scores on the questions that covered TBL-taught material than those covering traditional lecture-taught topics. The results of this study suggest that TBL-style lecture was more effective than traditional-style lecture for teaching fixed prosthodontics and that TBL was a more efficient mode of delivering dental education than traditional lecture-based teaching.

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Team-based learning (TBL) was initially developed by Larry Michaelsen at Oklahoma University Business School in the late 1970s. The expansion of his class size from 40 to 120 students required him to develop a new pedagogical paradigm: that of learning in small groups or teams. Over the subsequent 30 years, the idea of TBL was widely adopted for business administration and natural science curricula. The use of TBL for medical education was initiated at Wake Forest and Baylor universities. TBL is effective in allowing students to help each other during small-group discussions within a large class and through preparation before class. TBL...
The aims of our study were to evaluate the quality of TBL in prosthodontics education for fourth-year dental students at Tokushima University School of Dentistry and to compare this teaching method with traditional lecture-based delivery. In this article, we report the results of a trial introduction of TBL for teaching fixed prosthodontics. Traditional lecture-style and novel TBL-style classes were both held during a semester course of fixed prosthodontics. Student questionnaire feedback and term-end examination performance were used to evaluate the effectiveness of TBL.

Materials and Methods

This study was approved by the Research Ethics Committee of Tokushima University Hospital (No. 1893). For the study, 36 fourth-year dental students (22 males and 14 females) at the Tokushima University School of Dentistry attended the fixed prosthodontics course. Ten classes were held, which included three classes in the traditional lecture-style followed by an introduction to TBL and six actual TBL classes. In the TBL introduction, students were informed about what TBL is and what they needed to do in the class. The introduction is not necessary but helps familiarize students about the TBL-style lecture easily. Each class was 60 minutes long.

The traditional lecture-style classes were held using slide presentations and handouts. The students attended these lectures without any preparation. The TBL format is summarized schematically in Figure 1. One week before each TBL class, students were supplied with preparatory materials and needed to study the preparatory materials for the individual readiness assurance test (IRAT) and group readiness assurance test (GRAT), which were completed at the beginning of the next class. The TBL began with the IRAT (Figure 2) in multiple-choice format with a regular answer sheet to check each student’s preparation level. The GRAT had the same questions as the IRAT, and the student groups took the test after the group discussion. The GRAT used a scratch-card answer format and was preceded by active group discussions among the students. Each group was instructed to scratch away the seal for their selected answer and, if incorrect, to continue revealing answers until they selected the correct one. The number of scratched seals was used for scoring the GRAT. For example, if the correct answer was revealed at the first attempt, the student

![Figure 1. Format of the team-based learning (TBL) part of the course](attachment:figure1.png)

IRAT=individual readiness assurance test; GRAT=group readiness assurance test; GAP=group assignment project

TBL for dental education has been reported in the disciplines of periodontology, dental radiology, and removable prosthodontics. Pileggi and O’Neill reported that students taught by TBL exhibited enhanced critical analytic abilities and improved diagnostic skills in their final examination. Kumar and Gadbury-Amyot found that National Board Dental Examination (NBDE) results for the class after TBL teaching were slightly superior to national average scores. Haj-Ali and Al Quran reported that course grades were found to be higher in student cohorts using the TBL method compared with those taught by the traditional lecture-style method and that student evaluation and faculty feedback indicated strong support for TBL.
The final grade for each student at the end of this course unit consisted of 50% for the term-end examination results and 50% for their TBL evaluations. The TBL evaluations involved 15% IRAT, 15% GRAT, 10% GAP, and 10% peer evaluation, with further points available for groups asking questions. The percentage for each component was decided by the teacher and students.

Questionnaires with 10 items (Figure 4) and the results of term-end examinations were used to evaluate the outcomes of TBL. Regarding student evaluation, a questionnaire with five options per question was given to all students at the end of each class (traditional and TBL). Linear comparison was used for statistical analysis of the answers given. In addition, the term-end examination contained multiple-choice questions derived from both the TBL and traditional aspects of the course. Also, results...
from the term-end examinations from 2009 to 2013 were used to evaluate the effects of TBL. Classes during the period from 2009 to 2012 were taught in the traditional lecture format, and we compared the term-end examination scores between subjects that were covered by TBL-style lecture in 2013 and the same subjects that were taught in the traditional lectures in 2009-12. This also enabled comparison of results in each of these years against the TBL-style format used in 2013. The Wilcoxon signed rank test (a non-parametric test for correspondent variables) was used for the comparison.

The difference between the 2013 TBL-style classes and the traditional teaching in previous years was considered as a disparity score, which was calculated as the average score for the TBL questions minus the average score of the traditional lecture-style class questions for each student (since each year had different students and different questions). To compare examination results between each school year, we used Tukey’s honestly significant difference (HSD) test and the disparity of correct answer ratio between the questions covering the TBL and traditional lecture-style classes. SPSS 15.0J was used for statistical analysis. A p-value of <0.05 was used as the level of statistical significance.

**Results**

All 36 eligible students (100%) participated in the study. Results of the survey were significantly higher in the TBL groups than in the traditional lecture-style classes for the questions “Did you have an active attitude in this lecture?,” “Did you have enough time to prepare and review for the lecture?,” “Did the teacher specify the objective and grading standard of the lecture?,” and “Did you achieve the objective of the lecture?” The greatest improvement was seen for the question concerning preparation and revision time (Figure 5). We counted the student
question numbers during the class and found that the traditional-style lecture did not have any questions from the students and the TBL-style lecture had four or five questions per class.

The results of the term-end examination showed that the questions covering the TBL material scored significantly higher than those covering the lecture-taught material (Figure 6). The amount of disparity between the TBL and lecture scores was significantly higher in 2013 than in the other years.

Discussion

The original TBL structure reported by Michelaen et al. was adopted for this trial introduction, and our results confirm that this basic TBL format is effective for delivering prosthodontic education to Japanese students. The traditional education system in Japan is founded on a passive learning style in which students listen quietly to teachers delivering lessons and rarely interject with questions. In the traditional education system, almost no student studies before the class. Thus, students’ attention can often wander if they are not fully engaged in the lecture. Indeed, in the traditional lecture, the students occasionally lose concentration and ask few questions during these lectures. In contrast, the students were fully engaged in the TBL-style classes, actively participating in group discussions and asking considerably more questions during the feedback lecture after the GRAT (Figure 3). Since in TBL-style lectures, the IRAT and GRAT were given at the beginning of the class, the students needed to study and prepare for the tests. If the students did not prepare for the class, they should have received low scores on the IRAT and GRAT. Also, in TBL-style lectures the students needed to study by themselves and discussed actively with the group members in the class. The students could enjoy the group discussion much more.

The survey showed higher scores for the TBL on questions relating to attitude in class and preparation and review for the class. This finding reflects the increased preparation required for successful completion of the IRAT and GRAT components of the TBL. Furthermore, Japanese society values group benefit more highly than individual benefit. The group-based TBL is closely aligned with the predominant
Figure 5. Comparison of questionnaire scores on the team-based learning (TBL) (n=206 from six classes) and traditional lecture-style classes (n=92 from three classes)

*p<0.05, **p<0.01

Figure 6. Comparison of results of term-end examinations for questions derived from the team-based learning (TBL) and lecture-style class formats

Note: Panel A shows comparison between the TBL and traditional lecture-based teaching in 2013, showing the percentage of correct answers for each teaching format. **denotes p<0.01 as assessed by the Wilcoxon test. Panel B shows comparison of the correct answer ratio between the TBL in 2013 and the traditional lecture-style classes from 2009-12 that covered the same material as in 2013. The correct answer ratio was calculated as (average score for TBL-based questions) – (average score for lecture-based questions) for each student. **denotes p<0.01 (vs. 2013 result) as assessed by Tukey’s HSD.
Japanese culture and is thus highly advantageous for promoting student preparation in this population. Questions about specification of the objectives and degree of achievement also returned higher scores for TBL than for lecture-based teaching, suggesting that understanding the class objectives in TBL can lead to improved student satisfaction.

In the term-end examinations in 2013, students scored higher on questions derived from the TBL material than those covering the lecture-taught material. The disparity in these examination scores was higher than in the past four years, during which the course material was delivered by traditional lecture-style classes only. We conclude that this is a manifestation of the higher achievement in the TBL-based questions in 2013. TBL demands advance preparation to which students have responded positively, and it is likely that this approach to learning is more likely to resolve learning into long-term memory than the pure lecture format—hence the improved examination performance. Previous educational studies have reported that TBL is useful in the fields of diagnosis, oral and maxillofacial radiology, and removable denture prosthesis in various countries. These reports showed that TBL-style lecture could have good educational effects in the dental field worldwide.

Conclusion

We introduced TBL teaching to a component of dental education (fixed prosthodontics) at the Tokushima University School of Dentistry in Japan. The reported high student satisfaction and improved exam scores in this student cohort suggest that TBL is a more effective and efficient mode of delivering dental education than traditional lecture-based teaching.

REFERENCES