

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

Hisahiro Takeuchi, DDS, PhD; Katsuhiko Omoto, DDS; Kazuo Okura, DDS, PhD; Toyoko Tajima, DDS, PhD; Yoshitaka Suzuki, DDS, PhD; Maki Hosoki, DDS, PhD; Motoharu Koori, DDS, PhD; Shuji Shigemoto, DDS, PhD; Mayu Ueda, DDS, PhD; Keisuke Nishigawa, DDS, PhD; Omar Marianito Maningo Rodis, DMD, PhD; Yoshizo Matsuka, DDS, PhD

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.

Dr. Takeuchi is Associate Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Omoto is a postgraduate student, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Okura is Associate Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Tajima is Assistant Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Suzuki is Assistant Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Hosoki is Assistant Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Koori is Assistant Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Shigemoto is Assistant Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Ueda is Assistant Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Nishigawa is Associate Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; Dr. Rodis is Associate Professor, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan; and Dr. Matsuka is Professor, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, Tokushima, Japan. Direct correspondence to Dr. Yoshizo Matsuka, Department of Stomatognathic Function and Occlusal Reconstruction, Institute of Health Biosciences, Tokushima University Graduate School, 3-18-15 Kuramoto-cho, Tokushima, 770-8504, Japan; matsuka@tokushima-u.ac.jp.

Keywords: dental education, prosthodontics, team-based learning, educational methodology, Japan

Submitted for publication 3/12/14; accepted 8/18/14

Team-based learning (TBL) was initially developed by Larry Michaelsen at Oklahoma University Business School in the late 1970s.¹ 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.^{1,2} The use of TBL for medical education was initiated at Wake Forest and Baylor universities.¹

TBL is effective in allowing students to help each other during small-group discussions within a large class and through preparation before class. TBL

can be accomplished by one teacher conducting all group activities within a large class. This contrasts with problem-based learning (PBL), which uses similar small-group activities but generally requires independent tutors for each group to observe the progress of the group discussions.³ Furthermore, unlike PBL, TBL does not require compartmentalized space for group activities. All group discussions progress in open space, which promotes efficient interaction among groups.

TBL for dental education has been reported in the disciplines of periodontology,⁴ dental radiology,⁵ and removable prosthodontics.⁶ Pileggi and O'Neill reported that students taught by TBL exhibited enhanced critical analytic abilities and improved diagnostic skills in their final examination.⁴ 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.⁵ 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.⁶

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

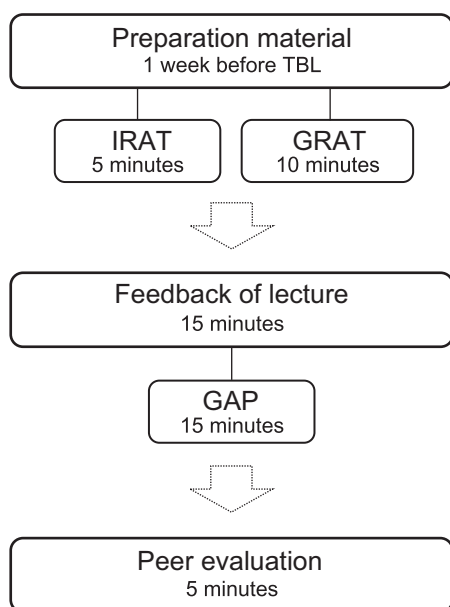


Figure 1. Format of the team-based learning (TBL) part of the course

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

- A**
- Q1. Choose one item that is not used for the evaluation of occlusal contacts.**
1. Inspection
 2. Palpation
 3. Thermal test
 4. Pull out technique
 5. Articulating paper
- Q2. Choose one item that is not used for the observation of occlusal contacts.**
1. Articulating paper
 2. Wax
 3. Silicone impression material
 4. T-scan
 5. Alginate impression material
- Q3. Choose one item that is used for occlusal adjustments.**
1. Rubber cup
 2. Rago reamer
 3. Peeso reamer
 4. White point
 5. Robinson brush
- Q4. Choose one item that is the most influential for the occlusal contacts of full metal restoration with precise indirect method.**
1. Casting shrinkage
 2. Deformation of mandible
 3. Accuracy of impression material
 4. Thermal expansion in investment
 5. Accuracy of occlusal registration material
- Q5. Choose one item that is not found with occlusal trauma.**
1. Mobility of tooth
 2. Enlargement of periodontal membrane space
 3. Missing of lamina dura
 4. Horizontal resorption of bone
 5. Furcation involvement

B

GRAT answering sheet						
Date:			Group number:			
Answer	1	2	3	4	5	Score
Q1	<input type="radio"/>	<input type="radio"/>	Yeah! (^-v^-)	<input type="radio"/>	<input type="radio"/>	10
Q2	<input type="radio"/>	<input type="radio"/>	Oops! (: _ :)	<input type="radio"/>	Yeah! (^-v^-)	5
Q3	Oops! (: _ :)	<input type="radio"/>	Oops! (: _ :)	Yeah! (^-v^-)	<input type="radio"/>	0
Q4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Q5	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	
Do not scratch marks except for the answer.					Total	

Figure 2. Sample questions for the IRAT and GRAT (panel A) and answer sheet for the GRAT (panel B)

Note: Panel A: The same questions, covering aspects of the fixed prosthodontics course, were used for both evaluations. Panel B: Correct answer on first attempt scored 10 points, one incorrect attempt scored 5 points, and two or more wrong answers scored 0 points. The total score for each question is seen in the right column.

IRAT=individual readiness assurance test; GRAT=group readiness assurance test

group scored 10 points. If revealed at the second attempt, they scored five points, whereas two or more wrong answers gave a score of 0. The GRAT scores were added to the IRAT score for each group member. If a student asked an insightful question during GRAT feedback, this was rewarded by the addition of bonus points to all group members.

Following teacher feedback with regard to the IRAT and GRAT questions, the students were given group assignment projects (GAPs), which involved clinical practical questions to test the students' ability to apply their learning to difficult clinical situations. Each group then presented its GAP findings to the class with number boards (Figure 3). Finally, peer evaluation was performed by each student, and scores were given to each of their group members for preparation, contribution to the group, consideration of other group members, and flexible ideas (Figure 4).

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

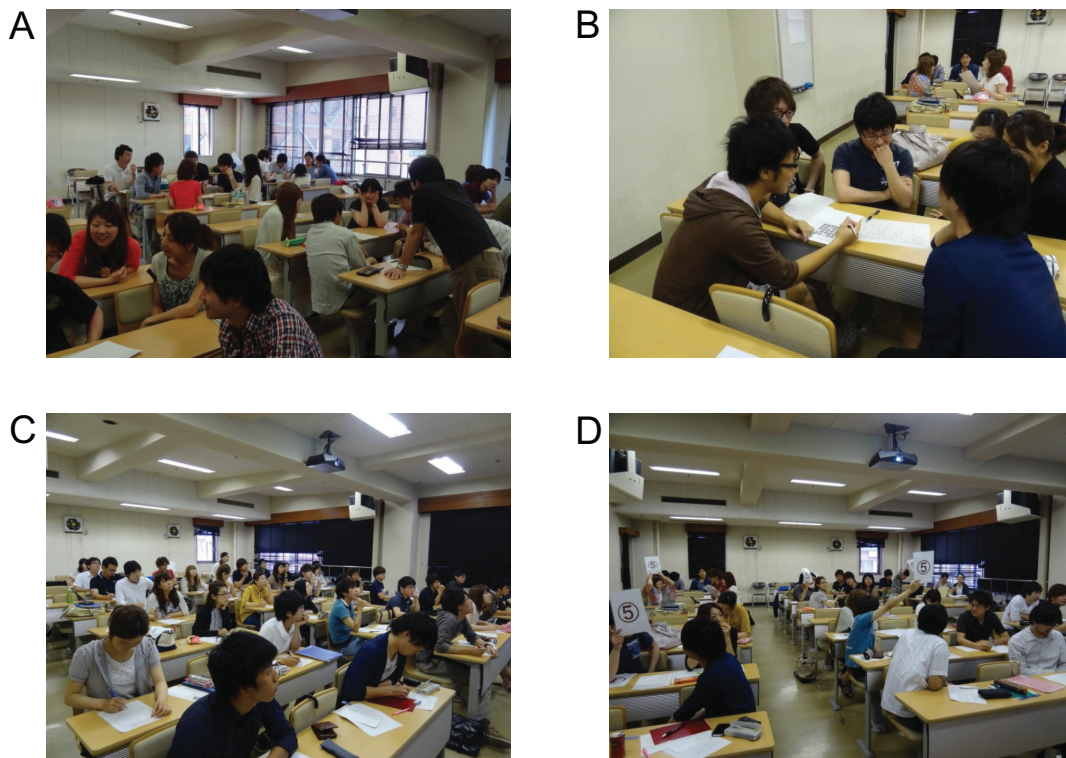


Figure 3. Class scenes in the team-based learning (TBL) classes

Note: Panels A and B show group discussion during the GRAT. Panel C shows the feedback lecture. Panel D shows a group presentation during the GAP.

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

A

Peer Evaluation Sheet

Date: _____

Group number		Your name	
--------------	--	-----------	--

Score your group members as: Excellent 5>4>3>2>1 Poor, for the following items. All members have to be scored with different scores. In the group that has more than 6 members, same number can be marked in one item. An absent member without sufficient reason is scored 0 point.

Student name	Preparation	Contribution	Consideration	Flexibility

Preparation: Have had enough preparation for the lecture
Contribution: Gives opinion actively in the group and performs active group discussion
Consideration: Helps other group members to perform group contribution
Flexibility: Have a wide viewpoint and listens to other member's opinion

B

1. Did you have an active attitude in this lecture?
2. Did you have enough time to prepare and review for the lecture?
3. Did the teacher specify the objective and grading standard of the lecture?
4. Did the teacher emphasize the important matters of the lecture?
5. Did the teacher make the lecture clear and understandable?
6. Did the teacher work out the lecture arrangement?
7. Did the teacher complete the specified lecture objective?
8. Did you achieve the objective of the lecture?
9. Do you think that this lecture is helpful in the future?
10. Did you have satisfaction with the lecture over all?

Answers

5 Yes
4 Rather yes
3 Neither yes nor no
2 Rather no
1 No

Figure 4. Peer evaluation sheet used for mutual evaluation by students (panel A) and the survey (panel B)

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 Michaelsen et al.⁷ 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

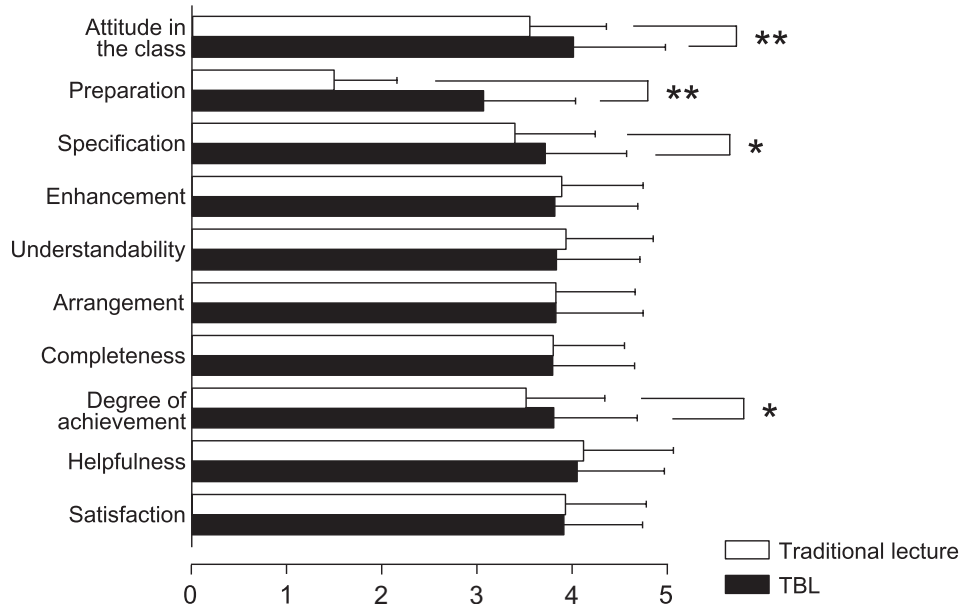


Figure 5. Comparison of questionnaire scores on the team-based learning (TBL) (n=206 from six classes) and traditional lecture-style classes (n=92 from three classes)

*p<0.05, **p<0.01

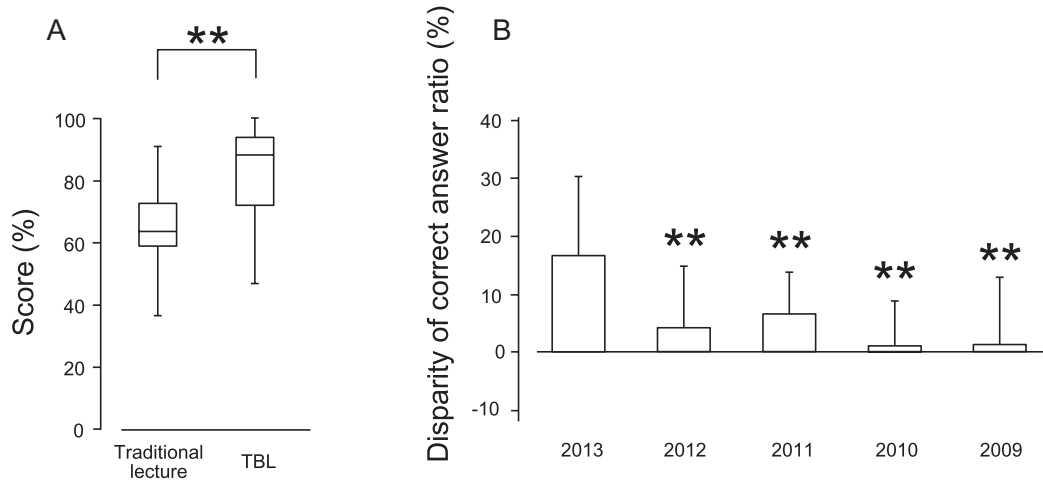


Figure 6. Comparison of results of term-end examinations for questions derived from the team-based learning (TBL) and lecture-style class formats

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.⁴⁻⁶ 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

1. Michaelsen LK, Knight BA, Fink LD. Team-based learning: a transformative use of small groups in college teaching. Sterling, VA: Stylus Publishing, 2004.
2. Parmelee S, Michaelsen LK, Cook S, Hudes PD. Team-based learning: a practical guide. AMEE guide no. 65. *Med Teach* 2012;34(5):e275-87.
3. Matsuka Y, Nakajima R, Miki H, et al. A problem-based learning tutorial for dental students regarding elderly residents in a nursing home in Japan. *J Dent Educ* 2012;76(12):1580-8.
4. Pileggi R, O'Neill PN. Team-based learning using an audience response system: an innovative method of teaching diagnosis to undergraduate dental students. *J Dent Educ* 2008;72(10):1182-8.
5. Kumar V, Gadbury-Amyot CC. A case-based and team-based learning model in oral and maxillofacial radiology. *J Dent Educ* 2012;76(3):330-7.
6. Haj-Ali R, Al Quran F. Team-based learning in a preclinical removable denture prosthesis module in a United Arab Emirates dental school. *J Dent Educ* 2013;77(3):351-7.
7. Michaelsen LK, Parmelee DX, McMahon KK, Levine RE. Team-based learning for health professions education: a guide to using small groups for improving learning. Sterling, VA: Stylus Publishing, 2007.