ORIGINAL

Effectiveness of conventional lecture, flipped classroom, and team-based learning in fixed prosthodontics : A term-end examination comparison

Kazuo Okura[1], Jaime Fabillar Jr[1], Mizuki Shinkai[1], Akari Shibagaki[1], Yasutomo Yoshihara[1], Masamitsu Oshima[1], Maki Hosoki[1], Yoshitaka Suzuki[1], Miho Inoue[1], Daisuke Ikutame[1], Swarnalakshmi Raman[2], Omar Marianito Maningo Rodis[3], and Yoshizo Matsuka[1]

[1]Department of Stomatognathic Function and Occlusion Reconstruction, Graduate School of Biomedical Sciences, Tokushima University, Tokushima, Japan, [2]Department of Neural and Pain Sciences, University of Maryland, U.S.A., [3]Department of International Oral Health Science Education, Graduate School of Biomedical Sciences, Tokushima University, Tokushima , Japan

Abstract : Active learning, including flipped classroom (FC) and team-based learning (TBL), is an instructional approach wherein students actively engage in self-directed learning. In FC format, students are required to study and/or take an examination, for some types, before the actual class. TBL format involves small group discussions, and students prepare for class by completing assigned tasks. However, no studies have compared the effectiveness of TBL, FC, and conventional lectures in the field of prosthodontics. Therefore, this study aimed to compare the effectiveness of conventional lectures, FC, and TBL formats by analyzing term-end examination data. We conducted a questionnaire survey of the items in accordance with the university class evaluation questionnaire. Dentists, including hospital residents and PhD students, achieved higher scores on the referential examination than undergraduate students. Students reported higher FC and TBL scores when normalized against dentists' scores, surpassing the scores obtained in conventional lectures. There were no significant differences in the validity or difficulty of questions across the various teaching formats. Moreover, student feedback via questionnaires indicated that FC and TBL formats provided more dedicated preparation and review time than conventional lectures. Our study highlights the effectiveness of FC and TBL in comparison to conventional lectures in fixed prosthodontics. J. Med. Invest. 73 : 44-51, February, 2026

Keywords **:** *conventional lecture, flipped classroom, team-based learning, fixed prosthodontics*

INTRODUCTION

Active learning, including flipped classroom (FC) and team-based learning (TBL), is an instructional approach wherein students actively engage in self-directed learning (1, 2). In FC format, students are required to study before the actual class, and some types of FCs require students to take an examination before the actual class (3, 4). With personal computers gaining popularity, digital slides and videos have become the primary learning materials in FC (5-8). Previous studies on FC in dental education reported that it significantly improved student knowledge compared to conventional lectures. Moreover, it also had the advantage of allowing students to learn at their own pace (9-11). In addition, a previous meta-analysis reported that FC is more likely to improve students' skills in dental radiology education than conventional lectures (12).

TBL, derived from FC, is a teaching format that involves small group discussions (2). Small group discussions are also a key component of problem-based learning (PBL), which is a well-known class format (13-17). However, PBL requires one tutor for each small group, resulting in a high demand for tutors in a class with larger number of students. In contrast, TBL discussions can be conducted by only a few faculty members, making the format more efficient. In TBL, students prepare for class by completing assigned reading or tasks. During the actual class, students take both an individual readiness assurance test (iRAT) and a team readiness assurance test (tRAT). After the tests, students engage in discussions and work on group assignment project (GAP) (18). TBL has been reported to improve learning motivation (19), national dental examination scores (20), class performance (21), student performance (22), and student attitudes (23) more than conventional lectures. In our prosthodontic classes, we found that TBL was more effective than conventional lectures (24-28). Additionally, the final examination results for TBL classes were significantly better than those of the conventional lecture format (24, 29).

To the best of our knowledge, no study has compared the effectiveness of TBL, FC, and conventional lectures in the field of prosthodontics. Therefore, this study aimed to compare the effectiveness of TBL, FC, and conventional lectures using term-end examination data.

MATERIALS AND METHODS

Class format of conventional lectures, FC, and TBL

Fixed prosthodontics classes were held from April 2014 to July 2017, where we conducted FC using e-learning (Tokushima University Learning Management System (LMS) ; Moodle, Manaba) in the first half of the semester and TBL in the second half (Table 1). In April 2018 to July 2019, conventional lectures were held in the first half of the semester, and TBL classes were held in the second half (Table 1).

In the conventional lecture format, teachers gave a 60-minute lecture per session (Fig. 1) using PowerPoint slides, which were

Received for publication May 9, 2025 ; accepted September 13, 2025.

Address correspondence and reprint requests to Yoshizo Matsuka, DDS, PhD, Department of Stomatognathic Function and Occlusal Reconstruction, Graduate School of Biomedical Sciences, Tokushima University, 3-18-15 Kuramoto-cho, Tokushima 770-8504, Japan and E-mail : matsuka@tokushima-u.ac.jp

available for download from the Tokushima University LMS (Moodle or Manaba). Although some teachers asked questions during lectures, the questions were not related to student evaluation. In the FC format, students were required to study the materials before class, which were also available in the Tokushima University LMS. Additionally, students were required to take an individual test consisting of five multiple-choice questions 1-7 days before the class. During the actual class, the teacher gave feedback on the individual test, explained the study materials, and provided instructions (Fig. 1). In the TBL format, students were also required to prepare before the class using study materials stored in the Tokushima University LMS. During the class, students took an iRAT followed by a tRAT, which involved group discussion. The questions administered in iRAT and tRAT were similar. In the tRAT, students used scratch sheets to find the correct answer. Correct answers on the first and second attempts earned the group 10 and 5 points, respectively, whereas using more than three attempts resulted in 0 points (Fig. 2). The teacher provided feedback on the tests. The students then discussed the GAP and received feedback. Finally, students evaluated other group members during peer evaluation sessions.

Table 1. Class format in a semester

Year	Class 1 ↔ Class 7	Class 8	Class 9 ↔ Class 15
2014-2017	FC	Special lecture	TBL
2018, 2019	Conventional lecture	Special lecture	TBL

Tokushima University has two semesters in an academic year, and each semester comprises 15 classes (60 min). Three types of learning (conventional lectures, FC, and TBL) were conducted in fixed prosthodontic classes. FC and TBL were conducted between 2014-2017. Conventional lectures and TBL sessions were conducted in 2018 and 2019, respectively.
FC : flipped classroom, TBL : team-based learning.

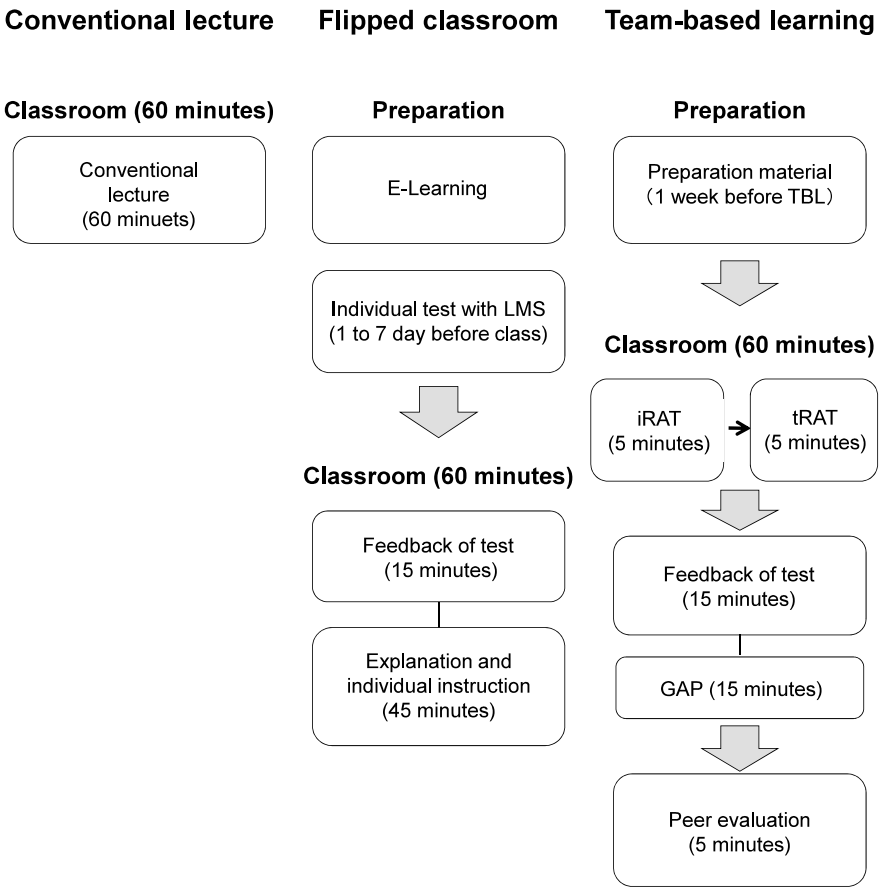

Fig 1. Schedule of conventional lecture, FC, and TBL formats.
The conventional lecture comprised a 60-minute lecture during each class. FC required students to study through LMS, followed by an individual test 1-7 days before class, and the actual class involved the teacher's feedback, explanation, and instructions. TBL allowed the students to study before class through LMS, and the actual class consisted of iRAT and tRAT, followed by the teacher's feedback before and after students' GAP discussion, and finally, group members' evaluation by the students. FC : flipped classroom, TBL : team-based learning, LMS : learning management system, iRAT : individual readiness assurance test, tRAT : team readiness assurance test, GAP : group assignment project

TBL group question (tRAT) answer sheet						
Date			**Group number:**			
Answer	**1**	**2**	**3**	**4**	**5**	**Score**
Question 1			Yeah! (-∇-)			10
Question 2			Oops! (; - ;)		Yeah! (-∇-)	5
Question 3	Oops! (; - ;)		Oops! (; - ;)	Yeah! (-∇-)		0
Question 4						
Question 5						
Scratch only the parts you want to answer 1st scratch correct: 10 points, 2nd: 5 points, 3rd & above: 0 points Enter the total in lower right corner					**Total**	

Fig 2. TBL group question (tRAT) answer sheet.
Students had to scratch to find the correct answer on the scratch sheet. The groups received 10 and 5 points for answering the question correctly on the first and second attempts, respectively. If the group took more than three attempts to answer correctly, it received 0 point for the question. tRAT : team readiness assurance test, iRAT : individual readiness assurance test

Learning outcomes

To assess the learning outcomes of different class formats (conventional lectures, FC, and TBL), the results of the final examination were analyzed. The final examination consisted of multiple-choice questions adapted from the Japanese National Dental Examination. To ensure the difficulty and validity of the final examination, referential examinations were administered to dentists, including hospital residents and PhD students, who were not involved in preparing the final examination questions. In this study, these dentists did not receive any lectures, unlike the students, but were nonetheless tasked with answering the same set of questions as those presented in the final examination.

We also analyzed the discrimination index and item response theory score. The discrimination index is a multivariate analysis of each person's performance and shows whether the questions are good for distinguishing between high- and low-performing students. More difficult questions with lower rates of correct answers were expected to be answered correctly by students with good grades than those with poor grades. In the present study, 25% was selected to represent high- and low-performing groups, such that the top 25% group and the bottom 25% group. The number of correct answers was divided by the total number of students in each group to determine their respective proportions. The discrimination index was determined by subtracting the proportion of correct answers in the bottom 25% group from the proportion of correct answers in the top 25% group. The discrimination index ranged from +1.0 to -1.0, with +1.0 representing the best discrimination question. Regarding the item response theory score, "item" refers to each question that makes up the test (each test question is referred to as an item), and "response" refers to whether the students answered the item correctly or incorrectly. The item response theory score shows the students' performance in the context of different questions (30-32).

At the end of the first and second semesters, we conducted a questionnaire survey on the items in accordance with the Tokushima University class evaluation questionnaire using e-learning (Table 2).

Statistical analysis

Statistical analysis was conducted using non-parametric tests. Kruskal-Wallis test was used to compare the class formats and examinees (students and dentists) in terms of correct answers to the final examination questions. Validity and difficulty of the examination questions and student questionnaire were assessed using the Mann-Whitney U test. EZR, a statistical software that extends the functions of R and R Commander, was used for statistical analyses. EZR is available free of charge on the Jichi Medical University Saitama Medical Center website.

Ethical considerations

Ethical approval was obtained from the Tokushima University Hospital Clinical Research Ethics Committee (No.1893) and the study was conducted in accordance with the tenets of Declaration of Helsinki.

Table 2. Student questionnaire items on conventional lecture, FC, and TBL.

What was the level of your understanding in this class?
On a scale of 0 (poor) to 4 (excellent), score this class for the following items :
1. Was your attendance attitude positive? (Positive attitude)
2. Did you do enough preparation and review before and after class? (Preparation / review)
3. Did the teacher explain the goals and objectives of the class? (Class objective)
4. Were the important things emphasized upon in the class? (Important things)
5. Did you understand the study subjects easily? (Study subjects)
6. Did you feel the ingenuity of the teacher in managing the class? (Ingenuity of teacher)
7. Was the class managed as planned? (Class plan)
8. Did you achieve the class goals? (Class goals)
9. Do you think this class would be useful for your future? (Class usefulness)
10. Did this class deepen your understanding of the subject? (Student understanding)
11. Did you feel the need or interest in studying the subject through this class? (Need / interest)
12. Did this class improve your ability to study the subject? (Improve ability)
13. Overall, were you satisfied with this class? (Overall satisfaction)
Student's free comments
Please answer the good points of this class.
Please answer what you want to improve in this class.

Questionnaire was administered at the end of each FC and TBL class.

RESULTS

Effectiveness of conventional lecture, FC, and TBL on term-end examination

The results of our analysis indicated that in most years, the percentage of correct answers was lower for students than for dentists (hospital residents and PhD students) (Fig. 3). We gathered data to analyze the differences in teaching styles and examinees (Fig. 4). Figure 4 shows the percentage of correct answers for each teaching style categorized by students and dentists. The term-end examination score was obtained from the student's score and the referential examination score was obtained from the dentists. The total numbers of students and dentists that were included in the study were 250 and 56, respectively. The dentists' scores were significantly higher than those of the students. Among the students, TBL score was significantly higher than conventional lecture score. To compare the effects of class format, we standardized the correct answer rate for each class format (Fig. 5). The student scores for each year were divided by the dentists' scores. After standardization, both TBL and FC scores were found to be statistically higher than the conventional lecture scores.

Validity and difficulty of the questions of term-end examinations

No significant differences were observed when comparing the discrimination index score of each question and item response theory score among conventional lecture, FC, and TBL (Figs. 6, 7). Figures 6 and 7 show that the validity and difficulty of questions were similar across conventional lecture, FC, and TBL formats. In addition, there were no significant differences in the scores of the dentists across the different teaching formats, indicating that the difficulty level of each teaching format was consistent (Fig. 4).

Student perspective in each teaching format

The answers to the student questionnaire in the context of conventional lectures, FC, and TBL showed significant differences among the teaching formats during preparation/review (Fig. 8). Students answered that they had more time for preparation and review before the class in FC and TBL formats than in the conventional lecture format. No significant differences were observed in terms of the other questions (Fig. 8).

DISCUSSION

In this study, the dentists' (hospital residents and PhD students) scores on the referential examination, similar to the term-end examination questions, were found to be higher than the student scores on the term-end examination. After dividing the students' scores by the dentists' scores, it was found that the students performed better in FC and TBL teaching formats than in conventional lectures. The validity and difficulty of questions for the three teaching formats did not show any significant difference. The student questionnaire showed that the students had more time to prepare and review for the class in FC and TBL formats than in the conventional lecture format.

There are two possible explanations for the dentists' scores being higher than the students' scores. First, dentists had studied extensively for the National Board Dental Examination before. Second, dentists had more clinical knowledge and experience in actual clinical situations than students.

The identification index showed that examinations in conventional lecture, FC, and TBL formats could distinguish between good- and poor-performing students. The identification indices of conventional lectures, FC, and TBL did not show any significant differences, and the validity of the examination questions was

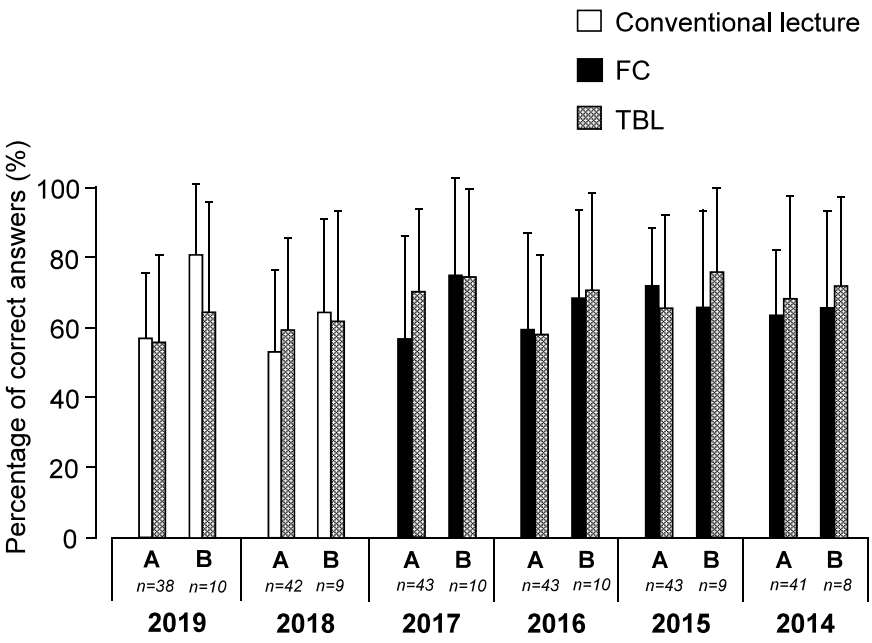

Fig 3. Percentage of correct answers obtained in each year.
The figure shows the correct answer rate of students in the final examination of each semester and the correct answer rate of dentists (hospital residents or PhD students) in the referential examinations. The referential examination questions were the same as those in the students' final examination. Hospital residents and PhD students were unaware of the questions before the examination. FC and TBL formats were conducted between 2014-2017, while conventional lectures and TBL were conducted in 2018 and 2019. Data are presented as mean ± SD. FC : flipped classroom, TBL : team-based learning, A : student score, B : dentist score

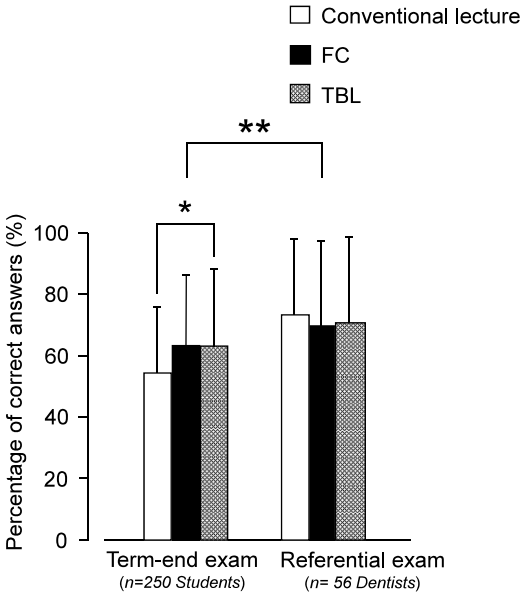

Fig 4. Percentage of correct answers obtained by students and dentists for each teaching format.
The figure presents a summary of data from 2014-2019. The term-end examination score was obtained from the student scores, and the referential examination score was attained from the dentists (hospital residents and PhD students). The dentist scores were significantly higher than the student scores. Among the students, the TBL score was significantly higher than that for the conventional lecture. Data are presented as mean ± SD. * : $P < 0.05$, ** : $P < 0.01$ with Kruskal-Wallis test and post-hoc test (Bonferroni correction). FC : flipped classroom, TBL : team-based learning

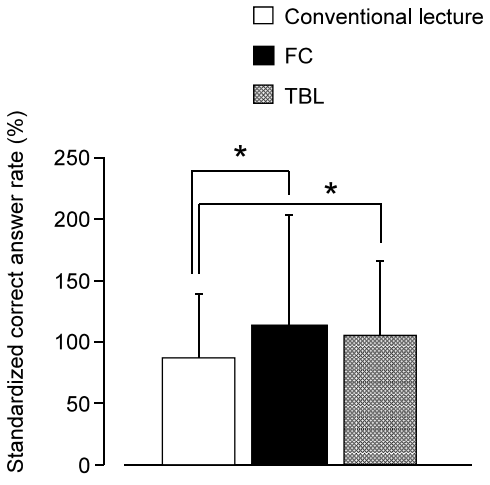

Fig 5. Standardized correct answer rate for each class format.
The figure presents the summarized data of standardized correct answer rates for each class format between 2014-2019. For standardization, the student score was divided by the dentist score each year. After standardization, TBL and FC scores were found to be significantly higher than those of conventional lectures. Data are presented as mean ± SD. ** : $P < 0.01$ with Kruskal-Wallis test and post-hoc test (Bonferroni correction). FC : flipped classroom, TBL : team-based learning

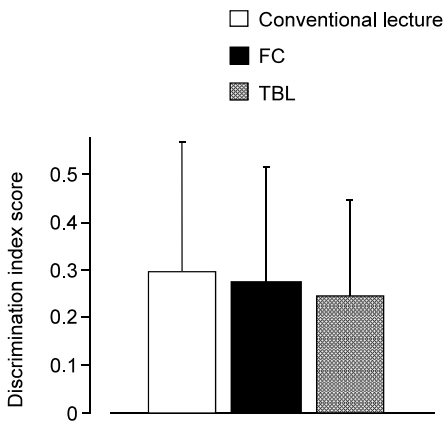

Fig 6. Average discrimination index score for each question
The figure shows the average Student Discrimination Index score for each question. The discrimination index provides an overview of how good students answered correctly. It is a multivariate analysis of each person's performance and question answer status, and is displayed in the range of +1.0 and -1.0. In terms of more difficult questions, students with good grades (high scores) may answer more correctly than those with poor grades (low scores). The best discrimination question was +1.0. Kruskal-Wallis test showed no significant difference among conventional class, FC, and TBL formats. Data are presented as mean ± SD. FC : flipped classroom, TBL : team-based learning

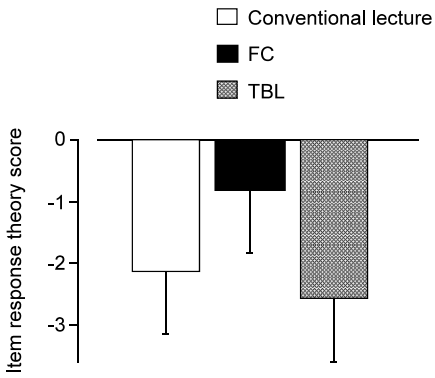

Fig 7. Item response theory score of each teaching style
"Item" refers to each question that makes up the test (each test question is referred to as an item), and "Response" refers to whether the students answered the item correctly or incorrectly. Since the students differed every year, the item response theory score indicated student performance with different questions. Kruskal-Wallis test showed no significant difference among conventional class, FC, and TBL formats. Data are presented as mean ± SD. FC : flipped classroom, TBL : team-based learning

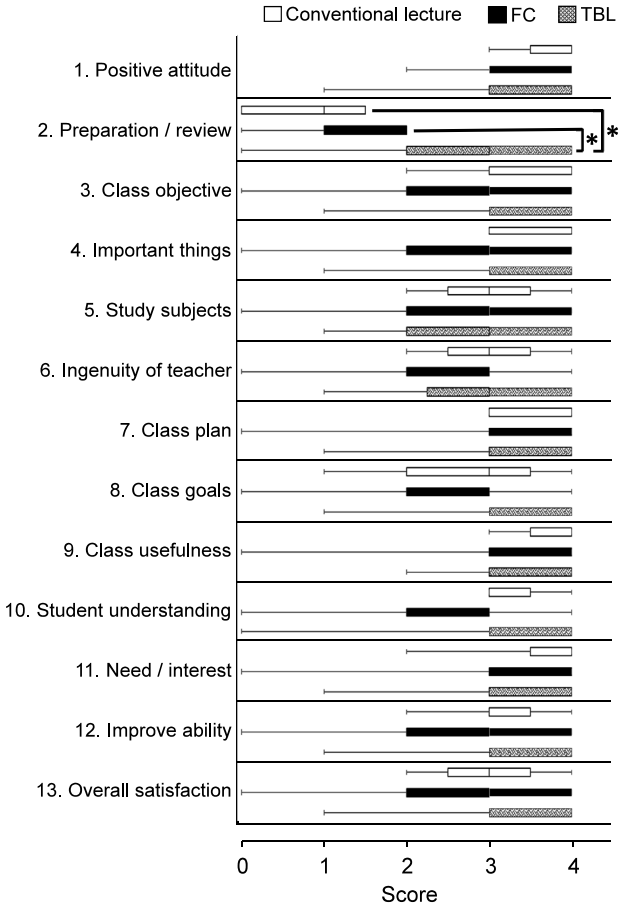

Fig 8. Student answer to the questionnaire
The student questions are listed in Table 2. The answers to the student questionnaire on conventional lectures, FC, and TBL showed a significant difference among the teaching formats in preparation/review. Students answered that they had more time for preparation and review before class in FC and TBL formats than in conventional lecture format. No significant differences were observed in terms of other questions. Data are presented as mean ± SD. * : $P < 0.05$ with Mann-Whitney U test. FC : flipped classroom, TBL : team-based learning

found to be similar across the three teaching formats. However, it is important to note that comparing the results using item response theory was challenging due to the annual variations in student composition and question selection. Consequently, the item response theory data showed no differences in the difficulty of examination questions among the conventional lecture, FC, and TBL formats. Therefore, we calculated the validity and difficulty of the examination questions. Additionally, the dentists' scores obtained from the referential examination indicated no differences among the teaching formats, further confirming the similar difficulty levels of the questions.

Previous studies reported that FC improved students' skills in dental radiology (12). In addition, TBL has been reported to improve students' diagnostic skills and critical analytic ability (19), National Board Examination results in Oral and Maxillofacial Radiology (20), and course grades on removable denture prosthesis (21). A previous study reported that the average correct answer rate of TBL showed higher term-end examination scores than conventional lectures (24). The present and previous studies show that FC and TBL are effective for education purposes (24-28, 33), as both these formats involve active learning and the students prepare for the actual class by themselves (1, 18-21, 24-28, 34-36). Active learning, including FC and TBL, requires students to study more than conventional lectures. This may explain why FC and TBL resulted in higher examination scores than conventional lectures.

More number of students answered positively to the question, "Did you do enough preparation and review before and after class?" in FC and TBL formats than the conventional lecture format. This is a reasonable finding as FC and TBL require preparation before the actual class. In addition, the results showed that TBL required more preparation than FC, however, the difference was not statistically significant. This is also reasonable as TBL requires discussion in an actual class. A previous data supports the finding that TBL outperforms FC in terms of positive attitude, preparation/review, class objective, ingenuity of the teacher, and class goals (28). When we compared the three teaching formats, a significant difference was only observed in the context of preparation/review.

The study has several limitations. The survey was conducted in a prosthodontic class in a dental school with a relatively small sample size. Thus, in future studies, it is recommended to increase the sample size and conduct surveys in other courses. Additionally, it would be beneficial to develop more effective class formats for active learning, aside from FC and TBL methods.

CONCLUSION

Our study highlights the effectiveness of FC and TBL in comparison to conventional lectures. The dentists outperformed the students. FC and TBL were associated with higher scores than conventional lectures, whereas question validity and difficulty remained consistent across all three formats. Furthermore, students reported dedicating more time to preparation and review in FC and TBL formats.

CONFLICT OF INTEREST DISCLOSURE

The authors declare no conflicts of interest.

ACKNOWLEDGEMENTS

The authors thank the students and dentists who participated in this study. The authors likewise thank Editage (www.editage.jp) for editing the English language.

REFERENCES

1. Lage MJ, Platt GL, Treglia M : Inverting the classroom : A gateway to creating an inclusive environment. J Econ Educ 31 : 30-43, 2000
2. Michaelsen L, Bauman Knight A, Fink LD : Team-based Learning. Westport, Greenwood Publishing Group Inc. 2002
3. Fischer KM, Sekula MN, Hannigan JD, Vaught RL, House H, De Souza GM, Williams TT : Effects of simulation-based flipped classroom in developing head and neck examination skills in dental students. J Dent Educ. 2024 doi : 10.1002/jdd.13490. Online ahead of print.
4. Karandish M, Karimian Z, Parastar M : Dental students in an orthodontic course flipped classroom : A semi-experimental study on knowledge, practice, attitude, and satisfaction. Clin Exp Dent Res 10 : e868, 2024
5. Schittek M, Mattheos N, Lyon HC, Attström R : Computer assisted learning : a review. Eur J Dent Educ 5 : 93-100, 2001
6. Hendricson W, Panagakos F, Eisenberg E, McDonald J, Guest G, Jones P, Johnson L, Cintron L : Electronic curriculum implementation at North American dental school. J Dent Educ 68 : 1041-1057, 2004
7. Faraone KL, Garrett PH, Romberg E : A blended learning approach to teaching pre-clinical complete denture prosthodontics. Eur J Dent Educ 17 : e22-e27, 2013
8. Farokhi MR, English DK, Boone SL, Amaechi BT : Health professions learners' evaluation of e-learning scenario-based case study design : Reinvigorating flipped classroom modalities. J Dent Educ 87 : 1754-1765, 2023
9. Garrison DR, Kanuka H : Blended learning : uncovering its transformative potential in higher education. Internet High Educ 7 : 95-105, 2004
10. Inamochi Y, Yoshida Kohno E, Wada J, Murakami N, Takaichi A, Arai Y, Ueno T, Fueki K, Wakabayashi N : Knowledge acquisition efficacy of a remote flipped classroom on learning about removable partial dentures. J Prosthodont Res 67 : 444-449, 2023
11. Zhong Y, Zhang Y, Sun W, Li L, Zhang W, Jiang Y, Lu X, Cai C, Wang H, Liu L, Xu Y : An outcomes-based module education via flipped classroom enhances undergraduate oral histopathology learning. BMC Med Educ 23 : 848, 2023
12. Ge L, Chen Y, Yan C, Chen Z, Liu J : Effectiveness of flipped classroom vs traditional lectures in radiology education : A meta-analysis. Medicine (Baltimore) 99 : e22430, 2020
13. Kuboki T, Sonoyama W, Arakawa H, Maekawa K, Suzuki K, Fujisawa T, Kojima S, Kasai T, Uehara J, Sugiyama H, Kanyama M, Yatani H : Problem-based learning on decision making in oral rehabilitation method selection for partial edentulous patients. J Okayama Dent Soc 22 : 229-236, 2003
14. Maekawa K, Maeda A, Uchibe K, Kitamura Y, Hikasa T, Uehara J, Kanyama M, Nawachi K, Arakawa H, Fujisawa T, Minakuchi H, Mine A, Matsuka Y, Kuboki T : Tutorial learning for the development of clinical decision-making ability in managing elderly patients with partial or total edentulism. J Jap Dent Educ Assoc 24 : 207-213, 2008
15. Matsuka Y, Isokane E, Kanyama M, Minakuchi H, Uehara J, Nawachi K, Ueda M, Oida Y, Mino T, Shinkawa S, Maekawa K, Arakawa H, Sonoyama W, Kuboki T : Effects of tutor skill on the educational outcomes of problem-based learning

in dentistry. J Okayama Dent Soc 28 : 11-17, 2009
16. Matsuka Y, Nawachi K, Kimura A, Kanyama M, Minakuchi H, Mino T, Maruhama K, Maekawa K, Fujisawa T, Sonoyama W, Mine A, Kikutani T, Kuboki T : A trial of problem-based learning on elderly patients in nursing homes. Jap J Gerodontology 26 : 36-45, 2011
17. Matsuka Y, Nakajima R, Miki H, Kimura A, Kanyama M, Minakuchi H, Shinkawa S, Takiuchi H, Nawachi K, Maekawa K, Arakawa H, Fujisawa T, Sonoyama W, Mine A, Hara ES, Kikutani T, Kuboki T : A problem-based learning tutorial for dental students regarding elderly residents in a nursing home in Japan. J Dent Educ 76 : 1580-1588, 2012
18. 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, Stylus Publishing, 2007
19. 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 72 : 1182-1188, 2008
20. Kumar V, Gadbury-Amyot CC : A case-based and team based learning model in oral and maxillofacial radiology. J Dent Educ 76 : 330-337, 2012
21. 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 77 : 351-357, 2013
22. Lochner L, Wieser H, Oberhöller G, Ausserhofer D : Interprofessional team-based learning in basic sciences : students' attitude and perception of communication and teamwork. Int J Med Educ 11 : 214-221, 2020
23. Ihm J, Shin Y, Seo D-G : Did clinical reasoning and knowledge questions during team-based learning enhance dental students' performance in esthetic dentistry? J Dent Educ 84 : 495-501, 2020
24. Takeuchi H, Omoto K, Okura K, Tajima T, Suzuki Y, Hosoki M, Koori M, Shigeto S, Ueda M, Nishigawa K, Rodis OM, Matsuka Y : Effects of team-based learning on fixed prosthodontic education in a Japanese School of Dentistry. J Dent Educ 79 : 417-423, 2015
25. Omoto K, Okura K, Tajima T, Suzuki Y, Hosoki M, Kori M, Shigemoto S, Ueda M, Nishigawa K, Matsuka Y : Introduction and effects of team-based learning on prosthodontics education. J Oral Health Biosci 27 : 81-87, 2015
26. Nishigawa K, Hayama R, Omoto K, Okura K, Tajima T, Suzuki Y, Hosoki M, Ueda M, Inoue M, Rodis OMM, Matsuka Y : Validity of Peer Evaluation for Team-Based Learning in a Dental School in Japan. J Dent Educ 81 : 1451-1456, 2017
27. Nishigawa K, Omoto K, Hayama R, Okura K, Tajima T, Suzuki Y, Hosoki M, Shigemoto S, Ueda M, Rodis OMM, Matsuka Y : Comparison between flipped classroom and team-based learning in fixed prosthodontic education. J Prosthodont Res 61 : 217-222, 2017
28. Hayama R, Okura K, Oshima M, Hosoki M, Suzuki Y, Miyagi M, Inoue M, Iwasa T, Dalanon J, Raju R, Rodis OMM, Matsuka Y : Longitudinal comparison between flipped classroom and team-based learning in a prosthodontic class. Journal of Oral Health and Biosciences 34 : 1-10, 2021
29. Nawabi S, Bilal R, Javed MQ : Team-based learning versus Traditional lecture-based learning : An investigation of students' perceptions and academic achievements. Pak J Med Sci 37 : 1080-1085, 2021
30. Akane A, Ito K, Hayashi A, Shiina K, Osawa K, Yanai H, Taguri M : Item analysis of non-curriculum-based ability test based upon discrimination index. Research Bulletin of National Center for University Entrance Examinations 35 : 19-47, 2006
31. Ito S : Expanding possibilities for test development with an item bank. Teaching Japanese as a Foreign Language 148 : 57-71, 2011
32. Usami S, Shojima K, Mitsunaga H, Todo N : Methods and practices in item response theory : A methodology to develop test and scale that maintain high-quality measurement. The Annual Report of Educational Psychology in Japan 58 : 321-329, 2019
33. Lee C, Kim SW : Effectiveness of a Flipped Classroom in Learning Periodontal Diagnosis and Treatment Planning. J Dent Educ 82 : 614-620, 2018
34. Bernard JS : The flipped classroom : fertile ground for nursing education research. Int J Nurs Educ Scholarsh 12 : 99-109, 2015
35. Ramnanan CJ, Pound LD : Advances in medical education and practice : student perceptions of the flipped classroom. Adv Med Educ Pract 8 : 63-73, 2017
36. Persky AM, McLaughlin JE : The flipped classroom – From theory to practice in health professional education. Am J Pharm Educ 81 : Article 1180, 2017