Application of a novel teaching model integrating multiple teaching methods in periodontology education for Chinese undergraduates

Xue Yang
School of Stomatology, Hospital of Stomatology, China Medical Univeristy
Shuangshuang Chen
School of Stomatology, Hospital of Stomatology, China Medical University
Chunliang Ma
School of Stamotology, Hospital of Stomatology,China Medical University
Xingyu Fan
School of Stomatology, Hospital of Stomatology, China Medical University
Jia Song
School of Stomatology, Hospital of Stomatology, China Medica University
Yaping Pan
School of Stomatology, Hospital of Stomatology, China Medical Univerisity
Xiaolin Tang (xltang@cmu.edu.cn)

Research article

Keywords: CBL, Flipped Classroom, Medical Education, PBL, Periodontology, Rain Classroom, TBL

Posted Date: January 24th, 2020

DOI: https://doi.org/10.21203/rs.2.21835/v1

Abstract

Background: The present research aims to explore and evaluate a novel teaching model called FC-integration, which integrates multiple teaching methods including flipped classroom, case-based learning (CBL), problem-based learning (PBL) and team-based learning (TBL) assisted by Rain Classroom in periodontology education for Chinese undergraduates.

Methods: 200 senior undergraduate students in Grade 2012, 2013 and 2015 were involved in this study from 2016 to 2019. The novel teaching model was applied to the chapter "gingival disease" for Grade 2013 and 2015 students (F group, n=118). As the control, the teacher gave a traditional lecture on the chapter "periodontitis" for Grade 2013 and 2015 students (T group 1, n=118) and the chapter " gingival disease " for Grade 2012 students (T group 2, n=82). The students finished a questionnaire and a quiz after the class.

Results: (1) The classroom atmosphere was more inspiring and animating in the F group than in the T group. The questionnaire survey showed higher satisfaction in the F group than in the T group (73.73% vs. 58.47%, $P< 0.05$). In addition, the Visual Analogue Scale (VAS) score in the F group was higher than that in the T group (7.69±1.69 vs. 7.03±1.91, $P <0.05$). (2) The average score on the quiz in the F group was higher than in the T group 1 (71.60±13.74 vs. 55.03±16.83, $P <0.05$) and T group 2 (71.60±13.74 vs. 63.92±12.34, $P <0.05$).

Conclusions: The application of the novel model could help students improve their learning efficiency and clinical skills in the diagnosis and therapy of periodontal diseases.

Background

Periodontology is an important and basic clinical topic in stomatology. It focuses on periodontal diseases in terms of etiology, clinical findings, diagnosis, treatments, prevention, etc. In recent years, medical tangle in China has increased dramatically. The phenomenon could be partly due to the inefficient medical education in China [1]. Most medical students have received little training in the use of theoretical knowledge to solve real clinical problems. As a result, students cannot treat clinical cases properly. Accordingly, it is extremely important to improve teaching quality. Unfortunately, there are some intractable problems in the education of stomatology in China. According to a survey in 2010, class hours for stomatology accounted only for approximately 30% of the total class hours in Chinese mainland medical schools compared with 60%-75% in the United States [2]. Zhong et al. [3] found that class hours for periodontology accounted for only 4.1% of the total class hours for stomatology in China. Moreover, traditional lectures only focus on knowledge transmission while ignoring knowledge assimilation. Students must review information after class without teachers’ assistance [4]. Therefore, a new teaching model is desperately needed to improve teaching efficiency for Chinese undergraduates.

The flipped classroom (FC) model, a new teaching model, reconstructs the learning process of students [5]. The FC is a flipped teaching arrangement derived from the traditional classroom and characterized by the delivery of materials in advance of the class session [6]. The class session is then dedicated to deeper discussion, Q&A and problem solving [5, 7]. There are many related studies on the FC model [8–10], and

some Chinese medical schools have used it in their pedagogy [11–13]. However, there are few reports on the application of the FC model in dental education, especially in the teaching of periodontology. In addition, problem-based learning (PBL), case-based learning (CBL) and team-based learning (TBL), including the FC model, are also student-centered learning methods aimed at emphasizing the students' self-learning and collaborative learning [14, 15]. However, no study has been reported on the integration of all these teaching methods, especially for the teaching of periodontology.

Information technology or networking can be used to deliver learning materials prior to a class session in the FC model [16]. Rain classroom (RC) is a new intelligent teaching tool developed by Tsinghua University. It can build a powerful learning platform with the help of WeChat on the mobile phone and PowerPoint on the computer. The purpose is to enhance the classroom teaching experience, and to make teachers and students more interactive and more convenient [17]. Teachers can also build groups on RC for the students to join in and share learning materials, fill out questionnaires, and so on. Therefore, RC is a promising method to improve the efficiency of classroom teaching.

In this study, we created a novel teaching model called FC-Integration. The model integrates multiple teaching methods, including flipped classroom, PBL, CBL and TBL, which is assisted by RC. The purpose of this study is to establish and evaluate the FC-Integration teaching model for periodontal education.

Methods

This study has been approved by the Institutional Ethnic Committee.

Teaching contents, participants and grouping

Teaching contents included the chapters on "gingival diseases" and "periodontitis" in the textbook on Periodontology edited by Huanxin Meng (4th edition) [18].The participants were 82 students in Grade 2012, 57 students in Grade 2013 and 61 students in Grade 2015 were involved in this study from 2016 to 2019 (n=200). They were all undergraduate students at the fourth year level at the School of Stomatology, China Medical University. All students received instruction from Prof. Xiaolin Tang. Students in Grade 2013 and 2015 were taught the "gingival diseases" chapter using the FC-integration model (F group, n=118). As the control, the teacher gave a traditional lecture on the chapter "periodontitis" for Grade 2013 and 2015 students and the chapter " gingival disease " for Grade 2012 students (T group 2, n=82).

Teaching procedure

The implementation process is shown in Figure 1.

In the F group, one week prior to the course, a RC group was established to deliver a PowerPoint file and a video file about the "gingival diseases" chapter. The video file had been shown on the website by the Chinese Stomatological Association in 2013 as an outstanding teachers' video made by Xiaolin Tang (http://www.cndent.com/index.php/Home/Index/news?newsId=2805). During the F group class, 6 typical clinical cases of gingival diseases were displayed according to the CBL teaching method. According to the

PBL teaching method, the teacher asked 10 questions for students to analyze and discuss in groups, also based on the TBL method. The cases and questions covered the key points of the courses. Finally, the teacher summarized the key points.

In the T group, the teacher was the center of the classroom and taught the students using PowerPoint and blackboard writing. There was little class discussion due to limited time.

After class, a questionnaire was released through the RC for students to rate the two models. The contents of the questionnaire includes a survey of satisfaction on a 5-point Likert scale and the Visual Analogue Scale/Score (VAS, 1=lowest rank; 10=highest rank, Table 1), and a few questions to evaluate the significance of the FC-integration model compared with the traditional teaching model (see Table 2 for specific contents). A test was then performed to evaluate the learning efficacy of the two teaching models. The questions included multiple-choice questions and short-answer questions. There were 10 multiple-choice questions at 5 points for each and 1 for short answer question at 50 points for a total score of 100 points. To ensure the accuracy of the evaluation, the quantity, type and difficulty of the tests designed for the two groups were matched with each other.

Statistics

All statistical analyses were performed using SPSS 21.0. The continuous variable data were tested using a one-sample K-S test to verify the normal distribution. The normal distribution data were compared using a paired-samples *t* test. A cross-tabulation analysis and a Chi-squared test were used to compare the satisfaction of the two models in the questionnaires. Significance was considered to occur at $P < 0.05$.

Results

Results of the questionnaire

Students in Grade 2013 and 2015 participated in the questionnaire survey (n=118). The results of questionnaire are as follows:

Comparison of satisfaction

The result of the Likert scale analysis showed that the satisfaction of the F group was significantly higher than that of the T group 1 (P=0.009). The overall satisfaction rate of the F group was 73.73%, and that of the T group 1 was 58.47%. In addition, 16.95% of the students in the F group rated that they were "very satisfied" with the model, and 56.78% were "satisfied", while fewer students in the T group 1 rated that they were "very satisfied" (11.02%) and "satisfied" (47.46%) with the traditional model (Table 1).

The results of VAS showed that the mean rating of the F group was 7.69±1.69, which is higher than that of the T group 1, 7.03±1.91 (P=0.005).

Evaluation of the FC-integration model

In total, 85.59% (101/118) of the students believed that the preclass preview of the PowerPoint and video files developed their self-learning potential and gave them a preliminary understanding of the courses; 68.64% of the students (81/118) believed that the FC model made the best use of class time to solve real-case problems and focused on the key knowledge points. In addition, 67.80% of the students (80/118) believed that the FC model was superior to the traditional model. Some students (45.76%, 54/118) could not understand the learning materials prior to class because they lacked self-learning abilities, and 17.80% of the students (21/118) felt that the FC-integration model had no influence on their learning ability. Moreover, 76.27% (90/118) of the students believed that CBL and PBL could help them in future clinical practice, and 77.12% (91/118) of the students believed that TBL could improve their abilities to communicate and solve difficulties. A total of 65.25% of the students (77/118) preferred to participate in TBL rather than self-learning, and 67.80% (80/118) of the students believed TBL could improve learning efficiency, especially for students with weak learning ability. Finally, 76.27% (90/118) of the students believed that the FC-integration model would contribute to their clinical practice in the future, and 61.86% (73/118) believed that it would help them improve test scores. See Table 2.

Evaluation of assistant teaching means—RC

In total, 81.36% of the students (96/118) believed that they could access more learning materials through the RC. In addition, 81.36% of the students (96/118) believed that they could communicate with teachers promptly and solve difficult problems using the RC group, and 71.19% (84/118) believed that the platform as well as the group could be used as an effective tool for the distribution of teaching materials. Moreover, 72.88% (86/118) believed that using the RC could improve their learning efficiency to the largest extent, while 71.19% (84/118) believed the RC was necessary to current instruction. Only 6.78% (8/118) believed that RC made little sense for assisting teaching and learning. See Table 2/Figure 2.

Comparison of the test scores

All of the students took the test. Compared with the T group 1 and the T group 2, the test scores of the F group were remarkably higher in the multichoice questions (P_1<0.001, P_2<0.001), short-answer questions (P_1<0.001, P_2=0.001) and total scores (P_1<0.001, P_2<0.001). See Table 3 and Table 4.

Discussion

This study explored a new type of teaching model, the FC-integration model that integrates FC, PBL, TBL and CBL and is assisted by RC. Although previous studies have tried to evaluate new teaching models, they have only focused on one or two teaching method(s) [19–21]. In the present research, the FC-integration teaching model was used in the teaching of periodontology, a highly practical subject. Fortunately, the results of our research demonstrate the effectiveness and advantages of the novel model.

Our results demonstrate that the FC model can help students improve their self-learning abilities. A total of 85.59% of the students believed that the preclass preparation activities developed their self-learning

potential, while 68.64% believed the FC model made the best use of class time. A meta-analysis reported that the FC method is associated with greater academic achievement than the traditional approach to higher-level learning outcomes in medical education [22]. Some researchers have used the FC model in stomatology education, for example, in dental anatomy [23, 24], a practical preclinical dental skills course [25] and a fixed prosthodontic course [20], and have achieved satisfactory results. Only one study reported finding the FC model effective when applied in the practice plan on periodontal diagnosis and treatment [26]. However, as opposed to our research, they used no other teaching method.

In the present research, regarding the CBL, PBL and TBL methods, the students highly praised their efficacy. Students believed that the CBL and PBL could help improve their future clinical practice. Furthermore, they believed that TBL could improve their abilities to communicate with each other and solve difficulties. Previous studies have demonstrated that CBL, PBL and TBL can obtain excellent outcomes in various courses [27–29]. In this study, we integrated CBL, PBL and TBL with the flipped classroom to form an organic integrity: the FC-integration model. By combining the advantages of these teaching models, students' initiative and interest in learning were enhanced, and their comprehensive analysis ability was improved.

In this study, most students provided positive comments about RC-assisted teaching. They believed that RC, a crucial teaching method, could assist teaching in a convenient and timely manner. These evaluation results demonstrate that RC is an efficient platform that can improve teaching efficiency. In previous studies, several platforms have been used to assist the application of the FC model. Real-time communication software plays an indispensable role in contemporary education and can improve teaching efficiency [30, 31]. Some scholars used networks such as the NextGenU website [32] and the Virtual Learning Environment (VLE) [25] established on the network to provide students with learning materials. However, compared with RC, these network platforms have some shortcomings. They lack the real-time communication function of RC. Moreover, their interfaces are not as concise and friendly as those in the RC. More importantly, RC helps students make use of their discrete time to study using their mobile phones.

The FC-integration model improves student test scores. We found that the scores of the F group were significantly higher than those of the T group. The objective choice questions mainly examine the students' mastery of the knowledge points, while short-answer questions mainly examine the students' ability to apply that knowledge. The above results indicate that students in the F group can grasp more knowledge points in a short time. The average of the total score of the control groups was 55.03 ± 16.83 (T group 1) and 63.92 ± 12.34 (T group 2), which indicates that it is difficult for students to grasp new knowledge efficiently when they receive only traditional classroom lectures.

Although the FC-integration model obtained positive feedback from the students in the present study, it nonetheless has some limitations. Stephney et al. [33] found that in a neuroanatomy course, the flipped classroom model did not improve the teaching process and results. A probable explanation is that the flipped classroom model may be not applicable to courses with complex and abstract contents. Therefore, this FC model is more suitable for teaching concrete and plain contents in medical education.

Conclusion

In conclusion, the results show that the FC-integration model can improve students' self-learning ability and clinical skills. Furthermore, this novel model will help teachers achieve the utmost teaching efficiency. In the future, we should improve this model and extend it to other clinical disciplines to make it more practical and feasible.

Abbreviations

CBL
Case-based learning; PBL:Problem-based learning; TBL:Team-based learning; VAS:Visual Analogue Scale/Score; FC:Flipped classroom; RC:Rain classroom

Declarations

Acknowledgments

This work was supported by the 13th Five-Year Plan Teaching Project of Liaoning Higher Education Institute (GHYB160025) and Liaoning Province Education Science "13th Five-Year Plan" 2016 Project (JG16DB513) in China.

Authors' contributions

All authors contributed to the study conception and design. X.Y. conceived and execution the study and drafted the article. S.C and C.M. performed collection of the data and statistical analysis. J.S. participated in the design of the study. X.T. led on conception of the study and participated in its design and coordination. X.F. helped to draft and revise the manuscript. All authors have approved the final version of the article submitted.

Funding

This study was funded by the 13th Five-Year Plan Teaching Project of Liaoning Higher Education Institute (GHYB160025) and Liaoning Province Education Science "13th Five-Year Plan" 2016 Project (JG16DB513) in China.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate

All procedures performed in studies involving human participants were in accordance with the ethical standards of the Medical Ethics Committee of China Medical University and Stomatology Hospital (No.K2017020) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study.

Consent for publication

Not applicable

Competing interests

The authors declare that they have no competing interests.

Author details

1 Department of Periodontology, School of Stomatology, Hospital of Stomatology, China Medical University, No. 117 Nanjing North Street, Heping District, Shenyang, Liaoning, China.

References

1. He AJ, Qian J. Explaining medical disputes in Chinese public hospitals: the doctor-patient relationship and its implications for health policy reforms. J Health Econ Policy Law. 2016;11(4):359-78.
2. Wu T CQ, Li DY. A Comparative Study on Higher Education of Stomatology in China and the United States. Fudan Education Forum. 2010;8(6):4.
3. Zhong JS, Hu W. Investigation of the teaching program of periodontology for the undergraduates in China. Chinese Journal of Conservative Dentistry. 2016;26:3.
4. Merriam SB. Updating our knowledge of adult learning. J Contin Educ Health Prof. 2010;16(3):136-43.
5. Tucker B. The flipped classroom: online instruction at home frees class time for learning. EdNext. 2012;12(1):2.

6. Strayer JF. How learning in an inverted classroom influences cooperation, innovation and task orientation. Learn Environ Res. 2012;15(2):171-93.
7. Moffett J. Twelve tips for "flipping" the classroom. Med Teach. 2015;37(4):331-6.
8. Mason GS, Shuman TR, Cook KE. Comparing the Effectiveness of an Inverted Classroom to a Traditional Classroom in an Upper-Division Engineering Course. IEEE T EDUC. 2013;56(4):430-5.
9. Mclaughlin JE, Griffin LM, Esserman DA, Davidson CA, Glatt DM, Roth MT, et al. Pharmacy student engagement, performance, and perception in a flipped satellite classroom. Am J Pharm Educ. 2013;77(9):196.
10. Rotellar C, Cain J. Research, Perspectives, and Recommendations on Implementing the Flipped Classroom. Am J Pharm Educ. 2016;80(2):34.
11. Sun HY, Qiu LH, Zhan FL, Xue M. Application of Flipped classroom combined with case-based learning in resident training of endodontics. Shanghai Kou Qiang Yi Xue. 2018;27(5):542-5.
12. Cheng X, Lee KKH, Chang EY, Yang X. The "flipped classroom" approach: Stimulating positive learning attitudes and improving mastery of histology among medical students. Anat Sci Educ. 2017;10(4):317-27.
13. Zhu H, Yan XL, Shen DJ, Zhang SN, Huang J. Application and exploration of micro-class combined with flipped classroom in cardiopulmonary resuscitation teaching for dental students. Shanghai Kou Qiang Yi Xue. 2018;27(3):333-6.
14. Shulman J. Case methods in teacher education: New York: Teachers College Press, Teachers College, Columbia University; 1992.
15. Barrows HS. The essentials of problem-based learning. J Dent Educ. 1998;62(9):630-3.
16. Tang B, Coret A, Qureshi A, Barron H, Ayala AP, Law M. Online Lectures in Undergraduate Medical Education: Scoping Review. JMIR Med Educ. 2018;4(1):e11.
17. Suo J, Hou XY. A Study on the Motivational Strategies in College English Flipped Classroom. English Language Teaching. 2017;10(5):62-67.
18. Meng H. The Periodontology. People's Medical Publishing House. 2012.
19. Bridges S. An emic lens into online learning environments in PBL in undergraduate dentistry. Pedagogies. 2015;10(1):22-37.
20. Nishigawa K, Omoto K, Hayama R, Okura K, Tajima T, Suzuki Y, et al. Comparison between flipped classroom and team-based learning in fixed prosthodontic education. J Prosthodont Res 2016;61(2):S1883195816300275.
21. Shigli K, Aswini YB, Fulari D, Sankeshwari B, Huddar D, Vikneshan M. Case-based learning: A study to ascertain the effectiveness in enhancing the knowledge among interns of an Indian dental institute. J Indian Prosthodont Soc. 2017;17(1):29-34.
22. Chen K-S, Monrouxe L, Lu Y-H, Jenq C-C, Chang Y-J, Chang Y-C, et al. Academic outcomes of flipped classroom learning: a meta-analysis. Med Educ. 2018;52:910-24.
23. Chutinan S, Riedy CA, Park SE. Student performance in a flipped classroom dental anatomy course. Eur J Dent Educ. 2018;22(3):e343.

24. Kellesarian SV. Flipping the Dental Anatomy Classroom. Dent J. 2018;6(3):23.
25. Crothers AJ, Bagg J, Mckenzie R. The Flipped Classroom for pre-clinical dental skills teaching - a reflective commentary. Br Dent J. 2017;222(9):709.
26. Lee C, Kim SW. Effectiveness of a Flipped Classroom in Learning Periodontal Diagnosis and Treatment Planning. J Dent Educ. 2018;82(6):614-20.
27. Fan C, Jiang B, Shi X, Wang E, Li Q. Update on research and application of problem-based learning in medical science education. Biochem Mol Biol Educ. 2018;46(2):186-94.
28. McLean. Case-Based Learning and its Application in Medical and Health-Care Fields: A Review of Worldwide Literature. J Med Educ Curric Dev 2016;3(3):39.
29. Reimschisel T, Herring AL, Huang J, Minor TJ. A systematic review of the published literature on team-based learning in health professions education. Med Teach. 2017;39(12):1227-37.
30. Gross D, Pietri ES, Anderson G, Moyano-Camihort K, Graham MJ. Increased Preclass Preparation Underlies Student Outcome Improvement in the Flipped Classroom. Cbe Life Sci Educ. 2015;14(4):ar36.
31. Yeonjeong P. A Pedagogical Framework for Mobile Learning: Categorizing Educational Applications of Mobile Technologies into Four Types. International Review of Research in Open & Distance Learning. 2011;12(2):78-102.
32. Galway LP, Corbett KK, Takaro TK, Kate T, Erica F. A novel integration of online and flipped classroom instructional models in public health higher education. BMC Med Educ. 2014;14(1):181.
33. Whillier S, Lystad RP. No differences in grades or level of satisfaction in a flipped classroom for neuroanatomy. J Chiropract Educ. 2015;29(2):127.

Tables

Table 1 Satisfaction with the FC-integration model

			Satisfaction Degree						
			Very Satisfied	Satisfied	normal	Unsatisfied	Very Unsatisfied	Total	*P**
Group	F Group	n	20	67	31	0	0	118	0.009
		%	16.95	56.78	26.27	0	0	100.00	
	T Group 1	n	13	56	46	0	3	118	
		%	11.02	47.46	38.98	0	2.54	100.00	

FC: Flipped Classroom; F group: the 2013 and 2015 students receiving the FC-integration teaching model; T group 1: the 2013 and 2015 students receiving the traditional teaching model. the teacher gave a traditional lecture on the chapter "periodontitis" for 2013 and 2015 students.

Table 2 Evaluation of the FC-integrated model and its significance

	Questions	Degree				
		Very Agree	Agree	Normal	Disagree	Very Disagree
The evaluation for FC integrated with CBL(PBL) and TBL	Help students fully develop self-learning abilities	47.46	38.14	12.71	1.69	0.00
	Help understand learning contents pre-class	29.66	38.98	27.97	3.39	0.00
	Cannot take full use of learning materials for students with poor self-study ability	5.08	40.68	30.51	18.64	5.08
	Help improve examination scores	22.03	39.83	34.75	3.39	0.00
	Better than traditional model	21.19	46.61	27.12	5.08	0.00
	No influences on Learning	1.69	16.10	27.97	45.76	6.78
	CBL and PBL can help future clinical practice	20.34	55.93	17.80	4.24	1.69
	TBL can improve their abilities to communicate and solve difficulties	34.75	42.37	18.64	4.24	0.00
	Prefer to participate in TBL compared with self-learning.	16.95	48.31	25.42	8.47	0.85
	TBL can improve learning efficiency, especially for students with weak learning ability.	17.80	50.00	27.97	4.24	0.00
The RC assistance	An efficient tool for instruction	40.68	40.68	16.10	2.54	0.00
	Can improve efficiency of instruction	31.36	41.53	25.42	1.69	0.00
	An essential tool for instruction	27.97	43.22	27.12	0.85	0.85
	Can deliver more learning videos and materials	38.98	42.37	14.41	3.39	0.85
	Being meaningless	1.69	5.08	32.20	51.69	9.32

FC: Flipped Classroom; CBL: Case-based Learning; PBL: Problem-based Learning; TBL: Team-based Learning; RC: Rain Classroom.

Table 3 Analysis of the Test Scores 1

	n	Multiple-choices scores [M(P25, P75)]	Objective questions scores	Total scores	*Pm*	*Po*	*Pt*
F group	118	90□90, 100□	7.92±3.08	71.60±13.74	<0.001	<0.001	<0.001
T group 1	118	70□60, 80□	6.39±3.45	55.03±16.83			

F group: the group receiving the FC-integration teaching model; T group 1: the 2013 and 2015 students receiving the traditional teaching model. *Pm*: *P* value of multiple-choices; *Po*: *P* value of objective questions scores; *Pt*: *P* value of total scores.

Table 4 Analysis of the Test Scores 2

	n	Multiple-choices scores [M(P25, P75)]□	Objective questions scores	Total scores	*Pm*	*Po*	*Pt*
F group	118	90□90, 100□	7.92±3.08	71.60±13.74	<0.001	0.001	<0.001
T group 2	82	85□80, 90□	6.46±2.73	63.92±12.34			

F group: the group receiving the FC-integration teaching model; T group 2: the 2012 students receiving the traditional teaching model. *Pm*: *P* value of multiple-choices; *Po*: *P* value of objective questions scores; *Pt*: *P* value of total scores.

Figures

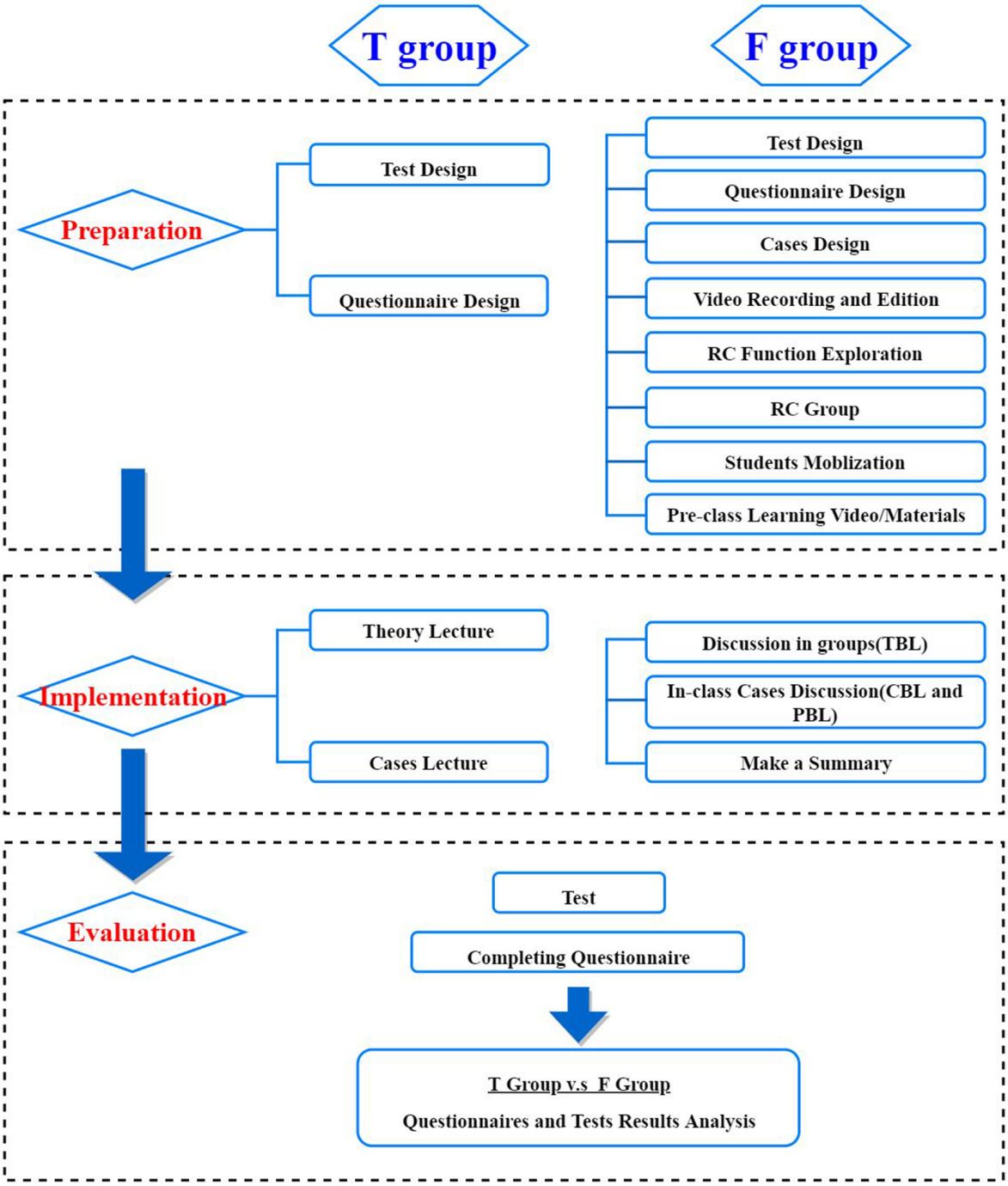
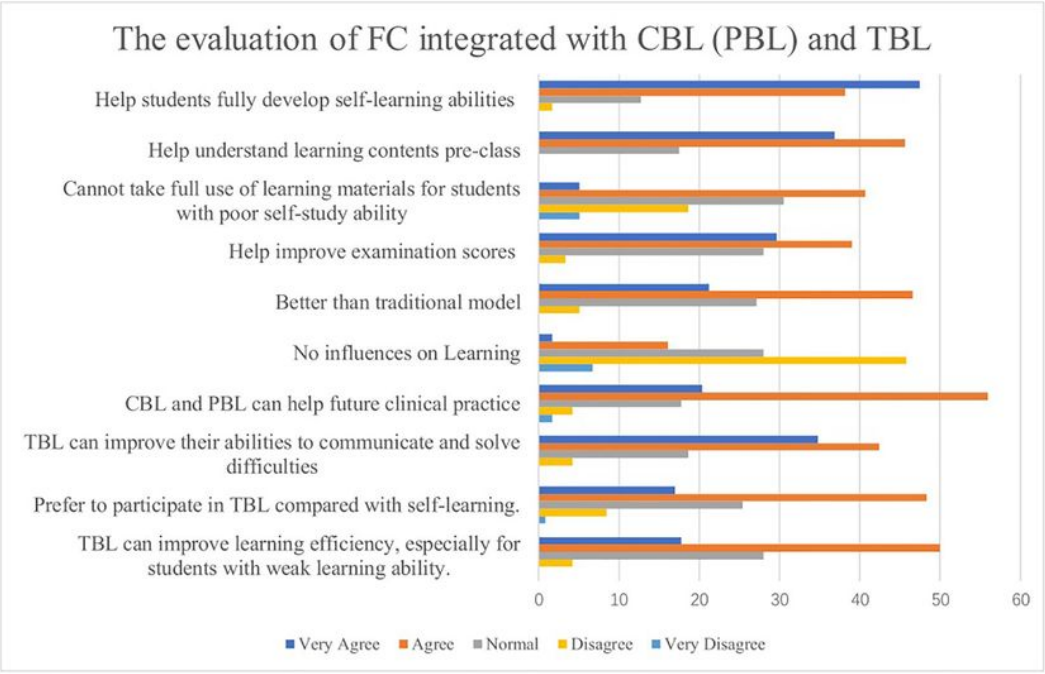
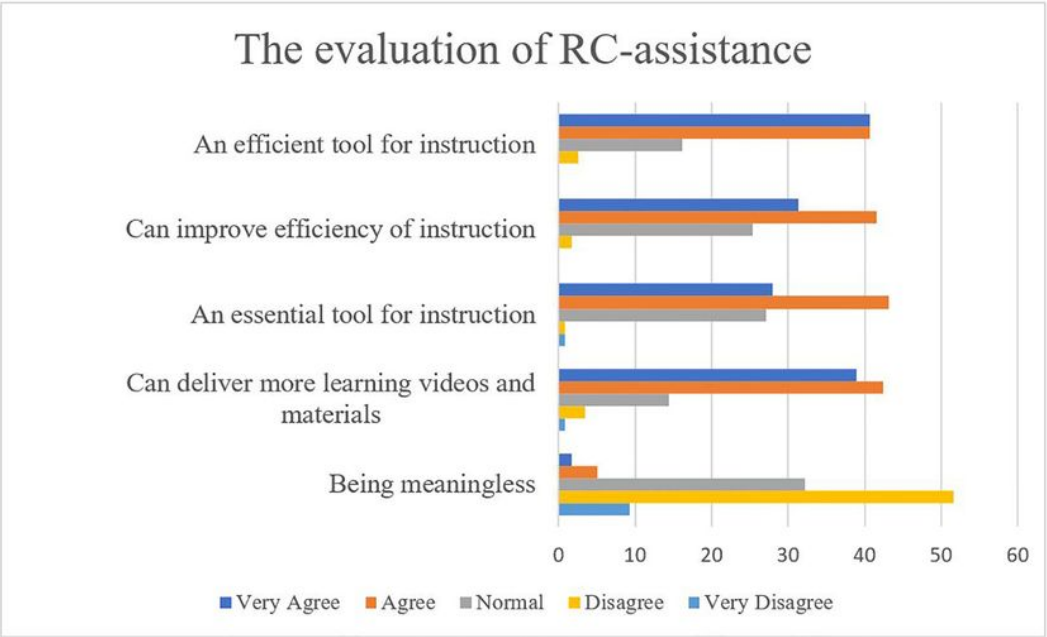


Figure 1

The flowchart of the teaching procedure F group: the group using the FC-integration teaching model; T group: the group using the traditional teaching model; RC: Rain Classroom.



A



B

Figure 2

Evaluation of the reform pedagogical model and its significance A: The evaluation of FC integrated with CBL (PBL) and TBL; B: The evaluation of RC-assistance. FC: Flipped Classroom; CBL: Case-based Learning; PBL: Problem-based Learning; TBL: Team-based Learning; RC: Rain Classroom.