Evaluationof Integrated Modular Teaching in Chinese Ophthalmology Trainee Courses

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Wei Xin
Sun Yat-Sen University Zhongshan Ophthalmic Center

Yuxian Zou
Sun Yat-Sen University Zhongshan Ophthalmic Center

Yong Ao
Sun Yat-Sen University Zhongshan Ophthalmic Center

Yu Cai
Sun Yat-Sen University Zhongshan Ophthalmic Center

Zheqian Huang
Sun Yat-Sen University Zhongshan Ophthalmic Center

Miaoling Li
Sun Yat-Sen University Zhongshan Ophthalmic Center

Chaochao Xu
Sun Yat-Sen University Zhongshan Ophthalmic Center

Yu Jia
Sun Yat-Sen University Zhongshan Ophthalmic Center

Ying Yang
Sun Yat-Sen University Zhongshan Ophthalmic Center

Yangfan Yang
Sun Yat-Sen University Zhongshan Ophthalmic Center

Haotian Lin
Sun Yat-Sen University Zhongshan Ophthalmic Center

haot.lin@hotmail.com*Corresponding Author*

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SUBJECT AREAS

Internal Medicine

KEYWORDS

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Abstract

Background: Before receiving ophthalmology trainee courses in Zhongshan Ophthalmic Centre, the medical students of Sun Yat-sen University had finished two years of premedical education, following thesix years of medical courses including basic medical course, clinical medical courses, clerkship, and research training in medical school. Integrated modular teaching using different problem-based teaching methods in Ophthalmology was designed bythe teaching steering committee of Zhongshan Ophthalmic Centre. This study aimed to evaluate the effectiveness and satisfaction scales of the integrated modular teaching among the trainee students. Methods: A total of 100 medical students who was receiving ophthalmology trainee courses in Zhongshan Ophthalmic Centre were enrolled, which were randomly allocated to 4 groups according to teaching arrangement, each of which contained 6 small groups.The trainee courses included several sections and multiple methods, such as "flipped classroom"section and team-based learning section. The pre-class test and post-class test were used to evaluate the effectiveness of the integrated modular teaching, and participants satisfaction survey questionnaire was collected to investigate the satisfaction among the participants.Results: Comparing with the first-day-test scores, the last-day-test score was significantly improved in total (t=3.288, P=0.001) in a pair t test. There was no significant difference of the last-day-test scores (F=1.163, P=0.328) in an ANOVA test among the four groups, even when the final grade of ophthalmology before entering the trainee courses was significantly different, and a significant difference of the first-day-test scores was found (F=7.614, P=0.000) among the four groups. Since the pre-class knowledge of ophthalmology could be evaluated by the final grade of ophthalmology before entering the trainee courses and the first-day-test scores, these results just showed us that the integrated modular teaching using in trainee courseswas effective and useful. There were 19 students who had an outstanding improvement with ranking ahead of more than 10 in all the participants in the last-day-test, which did not have higher average scores for daily performance than other students (t=0.469, P=0.654). According to the participant satisfaction questionnaires, these innovative teaching methods were considered effective and popular.Conclusions:Integrated modular teaching was effective and popular to the medical college

students in ophthalmology trainee courses.

Background

Ophthalmology is an independent and essential subject in medical teaching in which clinical-skill training and patient interaction play indispensable roles (Walsh, 2014). However, many medical students lack of sufficient practice in ophthalmology due to insufficient teaching time (Shah et al., 2014; Tsinopoulos et al., 2014). Most medical colleges teach ophthalmology in a conventional teaching style, in which the interest of the student is not engaged, the theory is not put into practice, and teaching efficiency is low. With advances in science and technology and multimedia innovations over the last several decades, new teaching methodologies have been introduced into medical teaching to improve learning efficiency, reduce classroom learning time and develop students' ability for autonomous learning. Because ophthalmology is a discipline that emphasizes practice, multimedia teaching method should shall be used to present a variety of ocular pictures and videos and to emphasize items of information repeatedly.

"Flipped classroom" (an inverted model of teaching that uses videos, podcasts or slides to deliver lecture material outside the classroom, so that classroom time is spent on discussion or problem-solving (Strayer, 2012)), team-based learning (TBL) (Burgess et al., 2014), simulation scenarios (Ahn and Kim, 2015), figure demonstrations (Karthikeyan and Kumar, 2014) and video demonstrations (Kurien et al., 2013) have been shown as effective teaching methodologies to promote the transformation of teaching from a teacher-centred approach to one that focuses on medical students. The use of TBL has been applied to ophthalmology and has proven to be an effective means of active learning (Altintas et al., 2014). However, most teaching assessments have been based on one or two teaching methodologies (Shetty et al., 2015; Qong et al., 2014; Aljarallah and Hassan, 2015; McMullen et al., 2013). Most subjects, including ophthalmology, seldom use a single model for teaching; instead, a multiple-mode teaching model is usual in the actual teaching process. Because every student has a preferred learning mode, it is necessary to integrate a variety of teaching modes to satisfy students' needs and improve their learning efficiency. Recently, integrated modular teaching using different teaching methodologies has shown improved results in dermatology (Karthikeyan and

Kumar, 2014).

In our study, 100 medical students from Sun Yat-sen University took part in an ophthalmology curriculum that was designed to incorporate multiple innovative teaching methodologies. This study aimed to assess the effectiveness and students' satisfaction of several major innovative teaching methods and to evaluate the validity and feasibility of integrated modular teaching in ophthalmology by using pre-tests, post-tests and daily performance.

Methods

Participants

This is a prospective study that enrolled 100 medical students who were entering their ninth semester in August 2015 and who were taking classes at Sun Yat-Sen University. The medical students chosen to evaluate the flipped classroom model are in the fifth year of an 8-year program at Sun Yat-sen University, located in Guangzhou, China. The students receive two years of premedical education and then follow a medical course that includes six years of basic medical, clinical medical, clerkship, and research training in medical school. These students were randomly allocated to 4 groups according to teaching arrangement, each of which contained 6 small groups (there were 3–6 students in each small group). The students participated in a 1-week integrated modular ophthalmology learning course at the Zhongshan Ophthalmic Centre. All the procedures in this study were videotaped, with the approval of the institutional review board of Zhongshan Ophthalmic Centre of Sun Yat-sen University (IRB-ZOC-SYSU) (Ethic ID: 2016MEKY062). Written informed consents have been obtained from all students.

Integrated modular teaching

Each module was initiated by a clinical teacher from the Zhongshan Ophthalmic Centre with a suitable introduction. This was followed by a discussion of individual topics. Pre-tests and post-tests were conducted at the beginning of the first module and the end of the last module, respectively, to assess the effectiveness of the integrated modular teaching system compared with different teaching modes. Test papers were based on the teachers' discussions and approved by the examination administration of Sun Yat-Sen University.

A total of 10 teaching modules with different teaching modes were conducted within 1 week. The topics of these modules included the anatomy of the eye, ophthalmologic examination, the lids and lacrimal apparatus, conjunctivitis and uveitis, keratitis, glaucoma, cataract and refractive error, the retina and ocular disorders associated with systemic disease, ocular trauma and blindness (Table 1). The details and survey questions of student perceptions regarding various teaching methods are presented in Table 2.

A comprehensive evaluation was conducted among all the enrolled students, basing on the comparison between a first-day evaluation and a last-day evaluation before and after the one-week integrated modular teaching with innovative teaching methods. The details of the questionnaire using in the comprehensive evaluation was displayed in Supplementary materials. The questionnaire contained two parts of contents. The first part was a case about a patient complaining single eye redness and blurred vision. Three questions about important signs, diagnosis and recommended examinations of this case were listed to be answered. The second part contained a list of important ocular symptoms and signs, such as phobia, tearing, itch sensation, foreign-body sensation, swelling pain and water cracks in the lens, etc. There were 5 cases in the 2nd part and the students were asked to select one or more related symptoms or signs to every case.

“Flipped classroom” section

The protocol of “flipped classroom” section has been published in the special issue on “Medical education for ophthalmology training” in *Annals of Eye Science* (ISSN 2520–4122; Ann Eye Sci; http://aes.amegroups.com), written by the same authors of the present article. The “flipped classroom” protocol was used for the ocular trauma teaching among fifth-year medical school students. The teachers who were selected to participate all have a wealth of clinical and teaching experience. Before the flipped classroom, relevant knowledge and questions based on a single ocular trauma case were delivered by public email. The students were asked to overview the knowledge of ocular trauma in groups using textbooks, published articles, e-publications or any other reference besides the email.

All of the students were randomly divided into four sections. Each section was randomly divided into

six groups. Three days before the flipped classroom sessions, the students were directed to review the subject of ocular trauma. One test consisting of three cases was completed by students in 20 minutes one day before the flipped classroom sessions. These three cases focus on penetrating injuries, contusions of the eyeball and chemical burns. Two or three questions were appended to each case scenario.

At the flipped classroom session, a group presentation was required in each group to present the understanding about ocular trauma in class and to highlight the key points and questions during self-learning or group-learning to others. The other students tried to answer the questions and discus the key points. After the discussion, the group who had just presented drew a summary. Four group presented in turn. Before the end of the class, the teacher summarised the questions and answers to promote the students' understanding. A post-class test was administered immediately to obtain feedback. Simultaneously, a questionnaire was finished by the student to investigate students' satisfaction scale.

Team-based learning module

The TBL module was designed according to the guidance (Parmelee & Michaelsen, 2010) and included: an Individual Readiness Assurance Test (IRAT), preparatory assignments, a Group Readiness Assurance Test (GRAT), a Group Application Problem (GAP) and final examination scores (FESs). The protocol of "team-based learning" section has been published in *PLoS One* (Huang et al., 2016), written by the same authors of the present article. Each group was given a random topic in the first day morning of the trainee course. The topics were closely linked to the content enrolled in this curriculum. The students had 5 days to prepare any form of presentation according to the assigned topic. Other related medical knowledge in addition to ophthalmology was permitted to be involved in the presentation or display. After every group presented their team-work in class, the teachers graded the students' presentations according to 5 criteria.

Statistical analytic methods

The difference between pre-class-test scores and post-class-test ones, between first-day-test scores and last-day-test ones were compared by using paired t test at the significance level of 0.05. One-way

analysis of variance (ANOVA) was used to compare the average scores of different groups or teaching methods. All analyses were performed using SPSS 20.0 software (SPSS Inc., Chicago, IL, USA).

Results

Basic information of the participants

The students, 50 males and 50 females, aged from 22 to 28 years old. we collected the following information from university records: 1) the admission scores as they entered the medical school were collected and there were no significant difference of the admission scores among the four groups ($F = 0.520$, $p = 0.669$). 2) the final grade for all curricula, which are provided as a standard numerical grade (SNG) on a scale from 0 to 100, including the following subjects: Obstetrics and Gynecology, Pediatrics, Psychiatry, Neurology, Emergency Medicine, Disaster Medicine, Otolaryngology Head and Neck Surgery, Anesthetics, Dermatovenerology, Internal Medicine, Surgery, and Ophthalmology. There was no significant difference of the final grade for all curricula among the four groups. 3) the final grade of ophthalmology subject was significantly different among the four groups ($F = 3.091$, $p = 0.031$), and the average final grade of ophthalmology subject in group 2 was the lowest among the four groups. However, there was no difference when compared one by one with a Student-Newman-Keuls test. All the basic information of the participants before their entering into the trainee courses was displayed in Figure 1.

Completion rate of the participants

All the 100 clinical medical students who took part in the ophthalmology trainee courses completed a pre-test and post-test in the integrated modular teaching provided by Zhongshan Ophthalmic Centre. All data were collected and analysed. Eight clinical teachers completed all the innovative teaching work together. There were no student complaints occurs during the trainee process.

Comparison between the effectiveness of TBL module and “flipped classroom” section

The average scores of pre-class test and post-class text in both team-based learning and the “flipped classroom” section were calculated and analyzed. We compared the pre-class scores with the post-test scores in each group using a paired *t* test. The students’ scores improved in the post-test not only

in TBL leaning section but also “flipped classroom” section in every group and in total (in total, TBL: t = 12.208, p = 0.000; “flipped classroom”: t = 37.822; p = 0.000) (Figure 2). We collected the students’ questionnaires and evaluated their acceptance of the 2 new teaching methods (Table 2) by calculating the number of students who responded with “agree”. The two teaching methods were widely supported, with 70% of the students believing that these teaching methods were useful for learning.

Comprehensive evaluation of the integrated modular teaching

A comprehensive evaluation was conducted among all the enrolled students by a first-day-test and last-day-test, which were organized before and after the integrated modular teaching with innovative teaching methods for a week. The average scores of each group, including the first-day-test and last-day-test, are presented in Figure 3. The paired t test was used to compare between the average score of first-day-test before our trainee courses and last-day-test after the courses in total. The last-day-test score was significantly improved in total (t = 3.288, P = 0.001), according to which we considered that the integrated modular teaching using in trainee courses was significantly effective. In addition, the pre-class knowledge of ophthalmology could be evaluated by the final grade of ophthalmology before entering the trainee courses and the first-day-test scores. As described above, the final grade of ophthalmology before entering the trainee courses was significantly different. And a significant difference of the first-day-test scores was found (F = 7.614, P = 0.000) among the four groups with an ANOVA test. However, as a result, there was no significant difference of the last-day-test scores (F = 1.163, P = 0.328) in another ANOVA test among the four groups. These results just showed us that the integrated modular teaching using in trainee courses was effective and useful. Comparing between the first-day-test scores and the last-day-test ones, we picked out 19 students who had an outstanding improvement with ranking ahead of more than 10 in all the participants in the last-day-test, which were called improvement group in Figure 3, and studied the daily performance of these outstanding students to discuss whether they put more attention in the classroom. However, they did not have higher average scores for daily performance than other

students (t = 0.469, P = 0.654).

Discussion

With the popularity and development of multimedia technology, computers and the internet in this information era, modern technologies can increasingly be used to replace traditional teaching methods and to usher in an era of rich teaching resources. The applications of modern technology and abundant public learning resources have promoted a reform from traditional teacher-centred teaching to a student-centred teaching mode. Student-centred teaching can cultivate higher-order thinking, problem solving and critical analysis and can provide feedback on the learning process (Gleason et al., 2011). Learning is a complex process, and previous studies have confirmed that increasing active learning can produce a better learning result (Harakuni et al., 2015; Jensen et al., 2015). Recently, a variety of student-centred teaching methods have been conducted in medical teaching (Shetty et al., 2015; Steedman et al., 2012).

The trainee courses of ophthalmology is in order to improve students' knowledge in clinical practice, to guide students to integrate knowledge in books with practice, and finally, to attract more outstanding students to the ophthalmology specialists. All the teaching module we conducting are problem-based. We usually say that more and more college students depend on what the teachers ask them to do and often ask what I shall do, instead of what the problems are and how I solve the problems. In the present courses, we encouraged the students to ask questions in team work. Of course they are excellent students, but in the past several years, most of them would rather keep silent with each other during the courses, with an excuse that "Anyway, I don't want to be an ophthalmologist." To ask question, discuss or even argue in the class, and finally answer the questions in team-work makes the trainee courses more interesting, impressive and popular, and exactly, more helpful to deep understanding of ophthalmology and more effective in comprehension of ophthalmology. In the present study, we designed a set of tests and questionnaires to investigate the effectiveness of the integrated modular teaching we conducting. Besides of the effectiveness, the trainee courses of ophthalmology now become a hot topic for students, which in fact has been another form of success for us.

The effectiveness of each major innovative teaching method was evaluated by a pre-test and post-test for 100 medical students. All students improved on the post-test. Most students were satisfied with the innovative teaching methods based on their answers to the questionnaire. Because every student has preferred learning habits and thinking modes, it is understandable that a small number of students did not agree with the effectiveness of the new teaching method, even if their test results improved. Overall, compound teaching modes are appropriate for most students' learning habits.

A comprehensive evaluation of compound teaching modes was conducted by comparing the results of the pre-test and post-test. Most students showed obvious progress on the post-test, suggesting that this multiple-mode teaching method is very effective in ophthalmology. Each group showed differences in their mastery of ophthalmologic knowledge based on a comparison of the pre-test scores but there were no differences in the post-test with regard to learning ophthalmology using multiple modes of teaching. This finding shows that our teaching methods are effective in narrowing the gap of learning achievement even if individuals differ in their initial degree of knowledge. In traditional teaching, the teacher-centred teaching method forces students to passively accept knowledge; thus, students' grades depend on listening in the classroom and reviewing the material after class and diligent students can obtain better grades. Therefore, different learning attitudes among students may make an enormous difference in the degree of knowledge that students master. However, these innovative teaching methods are based on student-centred teaching, which stimulates students' autonomous and active learning. These curricula were designed to be different modules using a variety of teaching methods, which could enhance students' interest in learning, reduce boredom and lead to greater acceptance by students. Therefore, integrating modular and multiple teaching methods can lead to effective teaching.

The multiple-mode teaching methods of this study included a "flipped classroom", simulation scenario teaching, case-based learning, and other methods that improved students' ability for autonomous learning. The ability to learn autonomously is very important for the life-long career growth of medical students (Dornan, 2012). Clinicians require life-long learning because natural scientific progress and innovation can lead to developments and revolutionary innovations in medicine. Only by constantly

keeping pace with the latest knowledge can doctors obtain a better understanding of diseases and new therapies and promote the progress of medical science. Therefore, the education of medical students involves not only teaching them professional knowledge but also teaching them how to take the initiative to study and how to use the educational platforms provided by modern science and technology. In addition, the ability to work in a team is particularly important for medical students because hospitals are workplaces based on teamwork (Watts et al., 2016). The TBL method could teach students how to learn from each other in a team and to make progress together. In summary, if medical students master self-learning and team-learning, they may be able to achieve faster growth in their subsequent professional growth and become more able learners. Compared with other medical majors, ophthalmology integrates more closely with advanced science and technology, such as the application of lasers, new materials, and optical instruments, which require ophthalmologists to maintain effective learning and to develop more autonomous learning than other specialists. Therefore, this teaching method might provide particular help for medical students who want to become ophthalmologists.

In our study, the students' daily performance was analysed. All students had poorer daily performances in team-based learning than the "flipped classroom" and case-based learning. The questionnaire showed the same result: TBL had a lower degree of recognition. A total of 19 students had an increase in academic performance by more than 10 grades in the post-test, but we did not find their better daily performance in class or attendance than other students. This finding can be explained by the possibility that all students have excellent class performance when autonomous learning awareness is triggered. This situation differs from traditional learning because greater effort is expended for the whole learning process, and more obvious improvement was shown. Nevertheless, it is not known whether the learning effect will decrease over time. Hence, we should follow these students to examine their learning ability and the durability of this method in a future study.

Conclusions

The students of eight-year program in medical college in China are the ones that have outstanding

admission scores and have excellent basis for learning and intelligence. Integrated modular teaching was conducted in these students aimed to gain as much improvement as possible in a short time during the trainee courses and to attract the outstanding students to ophthalmologists. In the present study, we confirmed the integrated modular teaching using in trainee courses was an effective teaching method and could be introduced to the trainee or teaching process of other medical specialized subjects.

Abbreviations

TBL, team-based learning; CBL, case-based learning; ANOVA, One-way analysis of variance

Declarations

Acknowledgements

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Availability of data and materials

Data can be shared upon request.

Competing Interests

The authors have no financial conflicts of interest.

Ethics approval and consent to participate

All the procedures in this study were approved by the Institutional Review Board of Zhongshan Ophthalmic Center of Sun Yat-sen University (Ethic ID: 2016MEKY062). Informed consent was obtained from each student.

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Tables

Table1 Modular teaching on 10 topics of ophthalmology and teaching methodologies.

Teaching methodology	Module
Lecture	Anatomy of the eye Ophthalmologic examination Lids and lacrimal apparatus Cataract and refractive error Retina and ocular disorders associated with systemic disease
Video demonstration	Anatomy of the eye Retina and ocular disorders associated with systemic disease
Practice	Anatomy of the eye Ophthalmologic examination,Cataract and refractive error
Photo demonstration	Lids and lacrimal apparatus Retina and ocular disorders associated with systemic disease
Case-based learning (CBL)	Conjunctivitis and uveitis, Keratitis
Simulation scenario teaching	Glaucoma
Flipped classroom	Ocular trauma
Team-based learning (TBL)	Blindness

Table2 Survey of Student Perceptions Regarding Two Teaching Methods

Survey Question	Number of Strongly Agree/Agree Responses (%	
	Flipped classroom	Team-based lea
It helped me to reach a higher level of knowledge	93.30	89.41
It was an effective, motivating learning process	89.90	83.53
It was well organized	100.00	94.12
It challenged me to give my best	95.00	81.18
It had a positive impact on my learning attitudes	93.20	78.82
I was satisfied with this teaching method	89.80	75.29
It should be offered more frequently	81.40	75.29

Figures

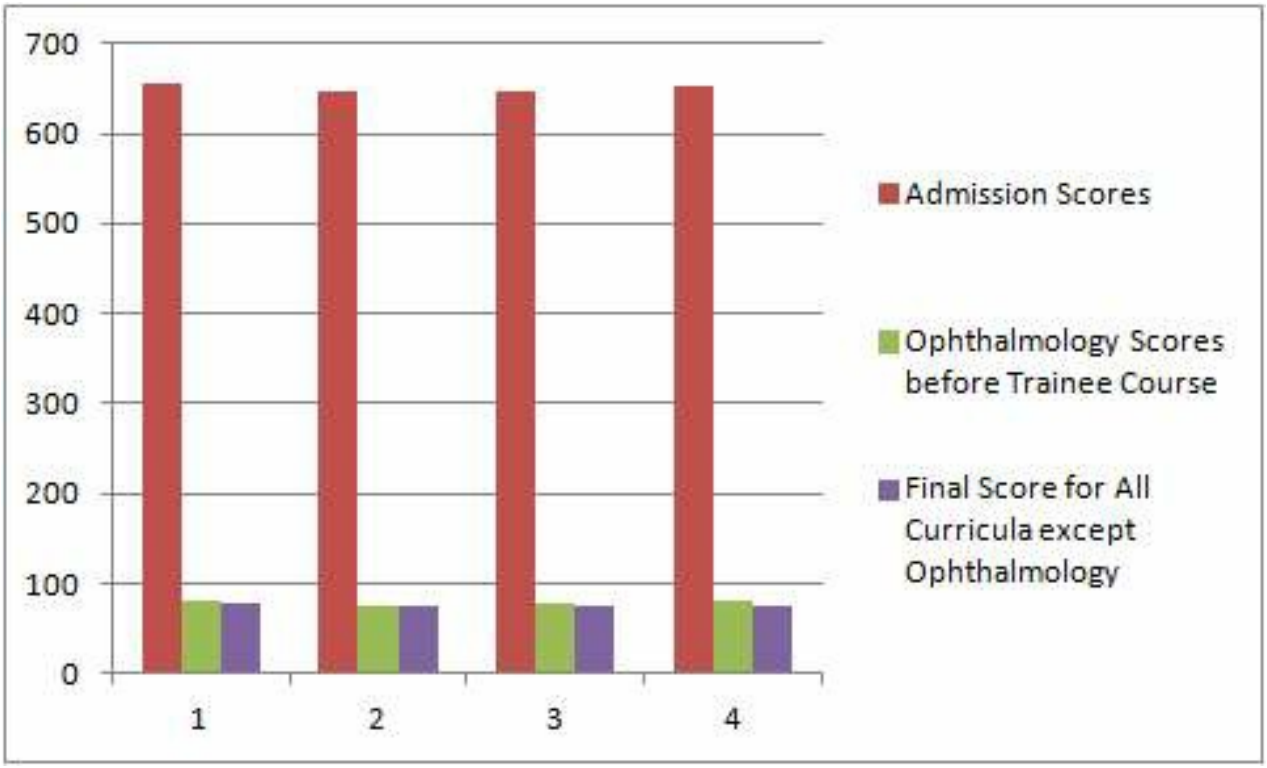

Figure 1

Basic information of the participants before their entering into the trainee courses.

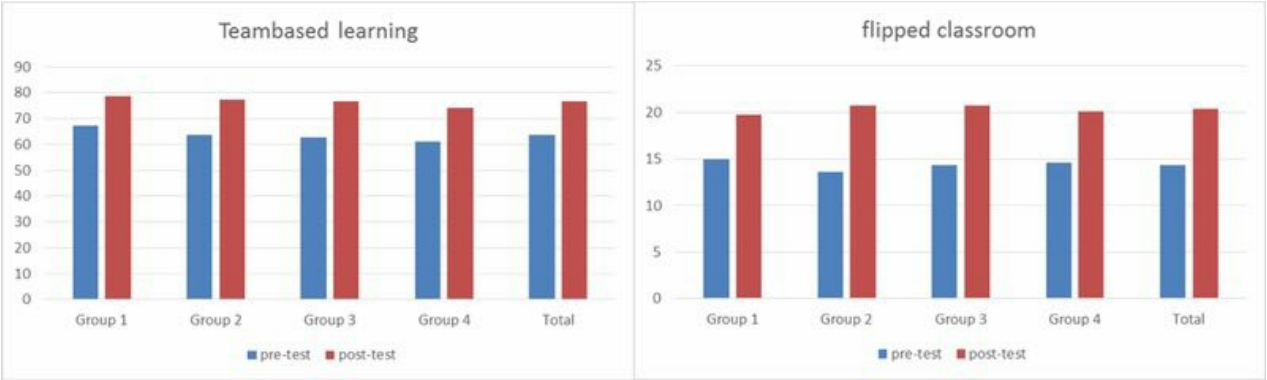

Figure 2

Average scores of the pre-class test and post-class test for team based learning (A) and flipped classroom (B) among the four groups and in total.

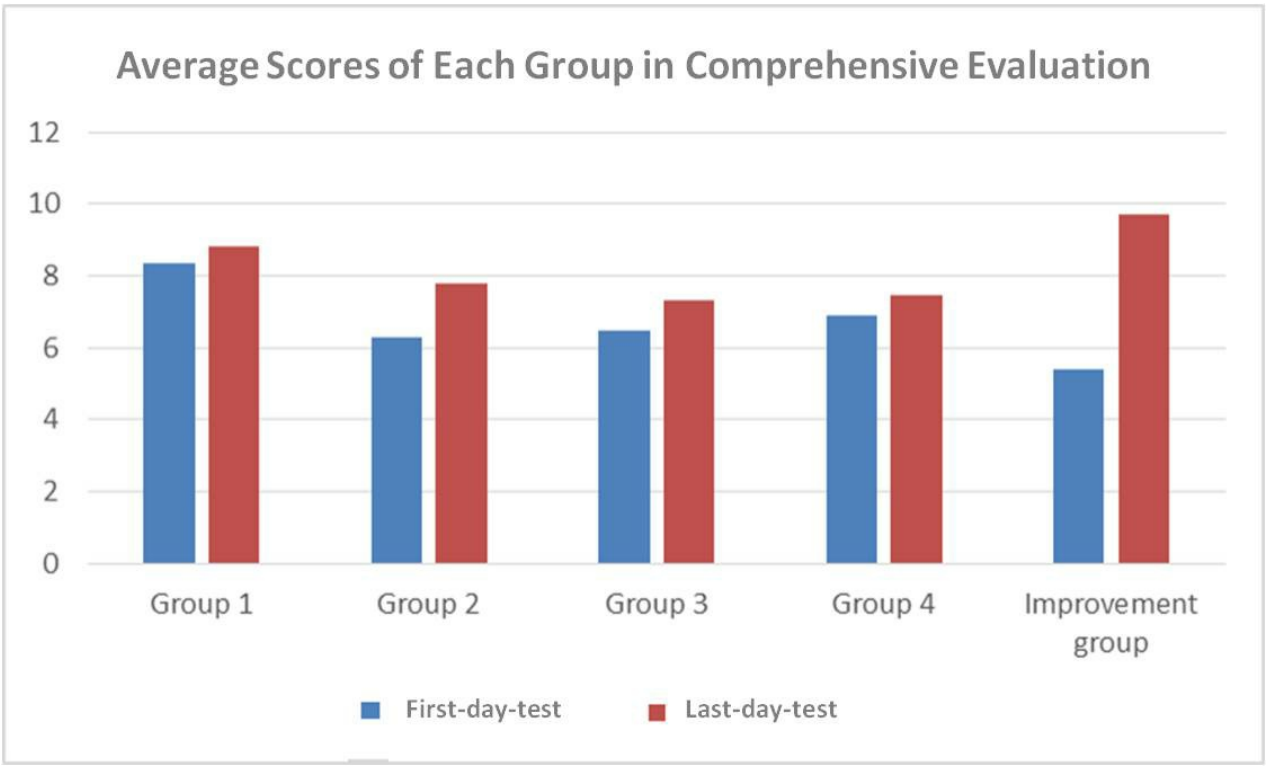

Figure 3

Average scores of each group in comprehensive evaluation. we picked out 19 students who had an outstanding improvement with ranking ahead of more than 10 in all the participants in the last-day-test, which were called improvement group.