

Team-based learning: assessing the impact on anatomy teaching in People's Republic of China

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Objectives: In this study, the effects of team-based learning (TBL) method on the anatomy course for students in People's Republic of China were assessed.

Methods: The students were randomly divided into the traditional lecture-based teaching group (traditional learning [TL] group, 99 students) and TBL teaching group (98 students). The TBL method required the students to prepare the assigned content in advance and discuss some specific topics in small groups. The test scores and questionnaire were applied to evaluate the effects of the two methods.

Results: The students in TBL group had higher examination scores (81.70 ± 8.53 vs 74.41 ± 8.27 , $F[1,195] = 124.6$, $p < 0.01$). The ratios of students with excellent (13.27% vs 9.09% , $\chi^2[1] = 4.00$, $p = 0.041$) and good scores (25.51% vs 16.16% , $\chi^2[1] = 4.85$, $p = 0.027$) were markedly increased in the TBL than the TL group, and the ratio of students who had just managed to pass was decreased (17.34% vs 32.33% in TL group, $\chi^2[1] = 5.91$, $p = 0.015$). The students in TBL group significantly achieved some improvement in mutual communication ability ($\chi^2[1] = 7.54$, $p = 0.006$), expression ability ($\chi^2[1] = 4.930$, $p = 0.026$), generalization capacity ($\chi^2[1] = 4.08$, $p = 0.043$), cooperative ability cultivation ($\chi^2[1] = 5.04$, $p = 0.024$), knowledge extension ($\chi^2[1] = 4.50$, $p = 0.034$), and enthusiasm mobilization ($\chi^2[1] = 4.27$, $p = 0.039$).

Conclusion: TBL could improve not only the test scores of the students, but also their study enthusiasm, initiative learning ability, communication ability, and team awareness.

Keywords: anatomy, lecture-based learning, student, team-based learning

Introduction

The team-based learning (TBL) concept was formally introduced by Larry Michaelsen as an educational modality at a business school in 1970, and this approach has since been adopted by a number of medical educators.¹⁻³ TBL is an active learning strategy which can provide opportunity for the students to apply their knowledge through discussions within small groups. Therefore, TBL has showed excellent effects on education in some clinical courses compared with the traditional lecture-based method.⁴⁻⁷

The anatomy course is a fundamental and difficult course for medical students. To improve the quality of anatomy education, previous researchers developed some methods, eg, problem-based learning method.⁸ However, our experience indicated that these methods were not effective for the students owing to the variety of educational or social backgrounds in People's Republic of China. The students frequently complained that they had not achieved the learning abilities and had only some anatomical

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knowledge. How to perform active learning and freely apply medical knowledge has been a growing critical concern for the students and their teachers.

Therefore, the aim of this study was to assess the effects of TBL method on anatomy in students, and this was compared with lecture-based learning method. Since the TBL has been shown to be effective in some disciplines, such as in physiology, medical genetics, nursing, and ethics education,^{9–12} in the present study, we hypothesized that the TBL will improve the educational effects on the anatomy course for the students.

Methods

Study design and participants

In this study, 197 students from the Medicine School of Chifeng College were recruited. These students were randomly divided into the lecture-based learning group (99 students, traditional learning, TL) and TBL teaching group (98 students). Additionally, each group had the same teaching hours.

The present study has been conducted according to the principles of the Declaration of Helsinki and Title 45, US Code of Federal Regulations, Part 46, Protection of Human Subjects, Revised November 13, 2001. All methods were approved by the Association of Medical Ethics of Peking University Health Science Center.

Study procedure

The TL method

Ninety-nine students were educated by the TL method, a teacher-centered theoretical (lecture-based) teaching that was performed according to the teaching program objectives. After completion of teaching, the teachers would reiterate the important and difficult points. Finally, the teachers would make a summary about the teaching content.

Each student in the TL group had an anatomy textbook (borrowed from library or purchased); all the content in the class was found in this anatomy textbook, and so the students could learn the content by themselves. The students were also required pre-read the related content in the anatomy textbook. The students in TL group could also interact with the teachers or peers, and they could freely ask the questions in the class, even during the lecture. After class, they also had opportunities to communicate voluntarily and individually with teachers or peers about medical knowledge. Each student in the class submitted to a test before and after the lecture sessions.

The TBL method

A week before the class, the content and the TBL procedure were informed to the students. Each group (4–5 students each

group, considering the gender and other characteristics) was given handouts for preparation. The students previewed the text independently and answered the questions individually using the resources they needed, such as notes and book. Following this, they were required to discuss the same questions within the group and provide 1 set of answers. The questions were formulated as multiple choices questions with only 1 correct answer. Groups of students practiced the problems on clinical diseases and related anatomical knowledge. Finally, the students filled out the peer evaluation forms for their team members. To check the primary outcome of the class, each of these students also submitted a test before and after the TBL sessions.

Data collection tool

To accurately evaluate the effects of 2 methods, we applied the following collection tools:

Test score

The final examination was taken by the students after TBL and TL education, and the total score was 100. All students were required to attend the examination. The scores were graded as excellent (90–100 marks), good (80–89 marks), moderate (70–79 marks), and pass (60–69 marks). Additionally, the number of students at each ranking in the TL and TBL groups was recorded.

Questionnaire

After being informed the reasons, the students in both TL and TBL groups completed the questionnaire freely. Additionally, the students were required to provide written informed consent to participate in this study. The following items were included in the questionnaire: the student's communication ability (communicating with teachers and classmates about the academic problems), expression ability (interpreting the opinions clearly), generalization ability (formulating general concepts from some clinical cases), collaboration ability (resolving the problems with others), knowledge extension (extension of knowledge from one discipline to another), learning initiative (studying the knowledge voluntarily), and classroom atmosphere (vivid and interactive classroom environment) during the anatomy class (Supplementary materials).

To determinate the face validity of this questionnaire, 3 authors of this study took part in a poll. Through applying corrective feedback, the questionnaire's face validity was confirmed. The attitude of students toward TBL was measured using the questionnaire with 7 items on a 3-point Likert scale

(including “agree,” “disagree,” “neither agree nor disagree”). The choices for each item were recorded, and the ratios of “agree” to each item in the TL and TBL groups were analyzed using χ^2 test (see “Data analysis” section). Totally, 197 questionnaires were issued and were received (ie, the withdrawing rate =100%). To prevent the students from communicating their opinions with each other, the significance of this study and the risk of such communication was explained. There was no data contamination according to their statements.

Data analysis

After being tested for homogeneity of variance, the examination scores of the students in TL and TBL groups were analyzed by using one way analysis of variance with the Tukey–Kramer post hoc tests. Additionally, the effect evaluation of 2 methods was performed by using χ^2 test. A p -value of <0.05 was considered significant.

Results

Comparison of final examination scores

In the final examination, 5 students in TL group scored excellent (90–100 marks), 13 students were good (80–89 marks), 50 students were moderate (70–79 marks), 32 had passed (60–69 marks). Meanwhile, 13 students in TBL group scored excellent, 25 students were good, 43 students were moderate, and 17 students had passed.

The ratio of students with excellent (13.27% vs 9.09% in TL group, $\chi^2[1] = 4.00$, $p=0.041$) and good scores (25.51% vs 16.16% in TL group, $\chi^2[1] = 4.85$, $p=0.027$) in the TBL group was markedly increased compared with the TL group. Additionally, the ratio of students in TBL group with a pass score was markedly decreased (17.34% vs 32.33% in TL group, $\chi^2[1] = 5.91$, $p=0.015$) compared with the TL group.

Furthermore, the average score in the TBL group was also higher than that in the TL group (81.70 ± 8.53 vs 74.41 ± 8.27 , $F[1,195] = 124.6$, $p<0.01$) (Table 1).

Evaluation of students

Through the questionnaire survey, the ratio of students who thought TBL method could mobilize the learning enthusiasm was 87.76% (vs 77.78%, $\chi^2[1] = 4.27$, $p=0.039$ compared with TL group); 89.80% students considered it could extend the knowledge scope (vs 78.79%, $\chi^2[1] = 4.50$, $p=0.034$, compared with TL group), 82.65% students thought it could cultivate cooperative ability (vs 72.73%, $\chi^2[1] = 5.04$, $p=0.024$, compared with TL group), 79.59% students deemed that their generalization ability was improved (vs 67.68%, $\chi^2[1] = 4.08$, $p=0.043$), 81.63% students considered that it could

Table 1 The comparison of average score and characteristics of students in TL and TBL groups

Samples (N=197)	TL group (N=99), (mean \pm SD)	TBL group (N=98), (mean \pm SD)
Average score	74.41 \pm 8.27	81.70 \pm 8.53 ^a
Age (year)	19 \pm 1.14	19 \pm 1.38
Gender		
Male	47 (47.48%)	50 (51.02%)
Female	52 (52.52%)	48 (48.98%)
Medical year	First year	First year

Note: ^a $p<0.01$ compared with that of TL group.

Abbreviations: TBL, team-based learning; TL, traditional learning.

boost their expression ability (vs 68.69%, $\chi^2[1] = 4.930$, $p=0.026$), 95.92% students thought it improved the classroom atmosphere (vs 84.85%, $\chi^2[1] = 6.93$, $p=0.008$), and 87.88% students considered that the communication with teachers was enhanced (vs 71.72% in TL group, $\chi^2[1] = 7.54$, $p=0.006$).

Discussion

In the present study, the TBL method was applied for the anatomy courses administered to the students in People’s Republic of China. The results of this study indicated that TBL enhanced the examination scores and the enthusiasm, initiative learning ability, communication ability, and team awareness of these students.

Anatomy is the first medical course undertaken by students in People’s Republic of China. In the traditional educational mode, the teachers impart anatomy knowledge in the class and evaluate the teaching effects merely through the scores of final examination.⁸ This method is not sufficient to introduce anatomy knowledge into the clinical courses, as the students passively learn the knowledge and gradually lose enthusiasm.

The TBL teaching concept, formally introduced by Larry Michaelsen, is a new educational mode that contributes to the development of team cooperation among the students.^{13–15} The TBL method can also overcome the shortage of teaching resources in some mountainous area.^{16–18} It is reported that TBL method showed better outcomes than traditional education in some preclinical courses.^{19,20}

In this study, we adopted the TBL concept as the principal method to assess the teaching effects on students.^{13–15,21} First, the students previewed the text independently and learned as much as possible from the anatomy books, and then the students were randomly divided into small groups, and the leader of each group managed the whole process. Finally,

the students were required to resolve some clinical question using the anatomy knowledge gained.

Additionally, based on previous studies,²² we designed some clinical cases based on the anatomy textbook and tried to include the questions on major anatomical and clinical knowledge. The results showed that TBL method could significantly improve the examination scores than TL, which is in accordance with the previous studies.^{21–23} Furthermore, our results also indicated that the enthusiasm, initiative learning ability, communication ability, and team awareness of these students were markedly enhanced when using TBL method, as was also reported by others.^{24,25} The ability of TBL method to resolve clinical problems were also reported by others.²⁶

In the present study, we used the examination scores and questionnaire to evaluate the effects of TBL method. In fact, there were some other methods also used to assess the TBL's effects. The median precourse and postcourse assessment scores were also used by others.²⁷ Furthermore, individual readiness assurance test, the group readiness assurance test, and the group application problem have also been applied to evaluate the effects of TBL.²⁸

There were some limitations of this study. First, similar to the previous studies,^{27,28} the relatively small sample size (totally 197 students) in this study limited the statistical power and weakened the significance of this study. Second, there was possibility that the students might have communicated their opinions with each other, which might have led to exchange of the information between 2 groups. To reduce this risk, based on the previous experience,²⁹ the significance of the study and the risk of communicating opinions with others was explained to them. There was no data contamination according to their statements. Third, the students in the TBL group might have known that they underwent an additional assignment, and thus the self-rated improvement in this study might be biased. To control this bias, we requested them to be fair because these results were just used for research not for grading. In addition, they were assured of the confidentiality of the data. Fourth, there were some subjective indexes in this study (eg, ability improvement). Although our results were encouraging, more objective evidence in medical education is required to verify the effectiveness of TBL method, as reported by the others.²¹ Lastly, in this study, the students were not simultaneously exposed to both TBL and TL, but others have reported this method.³⁰ In the future, the self-control study (eg, firstly adopt the TL method and then TBL method) might provide further evidence for the application of TBL method in medical education.

Conclusion

The present exploration of TBL method in anatomy teaching revealed that this method could improve not only the test scores of the students but also their study enthusiasm, initiative learning ability, communication ability, and team awareness. We believe that TBL is an effective and highly rated innovative learning method in basic medical sciences. This will lead more universities in world to adopt it and provide more active learning and deeper understanding of the basic medical sciences for the medical students.

Acknowledgment

We thank Professor Ruimao Zheng from Harvard University for refining the English writing in this work.

Disclosure

The authors report no conflicts of interest in this work.

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Supplementary materials

Questionnaire for the effects of the anatomy course

Items	Description	Response
Communication ability	Whether your communication with the teachers or students is enhanced	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;
Expression ability	Whether your language skill is enhanced	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;
Generalization ability	Whether your generalization ability is boosted	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;
Collaboration ability	Whether your cooperative ability is improved	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;
Knowledge extension	Whether your scope of knowledge is expanded	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;
Learning initiative	Whether your learning initiative is increased	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;
Classroom atmosphere	Whether the atmosphere in anatomy class is activated	<input type="checkbox"/> A; <input type="checkbox"/> B; <input type="checkbox"/> C;

Note: A: agree; B: disagree; C: neither agree nor disagree.

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