

Comparison of problem-based and team-based learning on Chinese basic medical education for clinical medicine: a pilot study

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Research article

Keywords: Problem-based learning, Team-based learning, Basic-medical curriculum

Posted Date: May 1st, 2020

DOI: <https://doi.org/10.21203/rs.3.rs-23853/v1>

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Abstract

Background

Since being proposed half a century ago, problem-based learning (PBL) and team-based learning (TBL) have been two popular teaching approaches used in Chinese basic medical education. To compensate for the shortcomings of lecture-based learning (LBL), both PBL and TBL can greatly benefit students. This study compares the differences of PBL and TBL on active learning and final academic scores in Chinese basic medical curriculum at Shantou University Medical College (SUMC).

Methods

Ten Year 4 and thirteen Year 3 medical students, enrolled in 2015 and 2016 at SUMC, were selected for TBL and PBL, respectively. In the homeostasis module, a basic-medical curriculum used in China, TBL was used for Year 4 students at their 3rd year, and PBL was used for Year 3 students. Student feedback was collected through a questionnaire. Academic achievement was based on their final examination scores. Each grade used the same final examination paper, which included both memorization and clinical application questions, as students in the traditional LBL class. Quantitative data were analyzed by t- and nonparametric tests.

Results

All students completed the questionnaire. Most students (PBL:62%, TBL:90%) thought the teaching approach they used was good for training clinical thinking, but PBL required more time and imposed a greater study burden. However, PBL students received higher scores than LBL students for clinical application essays ($p < 0.05$), whereas there were no differences in memorization problem scores. Final academic scores showed no significant differences between TBL and LBL students ($p > 0.05$).

Conclusion

Despite the differences in the culture of learning between China and the West, TBL and PBL are two popular teaching approaches among Chinese medical students. In Chinese basic medical education, PBL is more effective in training clinical thinking, while in TBL, students spend less time with problems and are helped by the professors. The relevant assessment system and teacher training system should be perfected.

Background

Following tradition, many medical colleges use a lecture-based learning (LBL) approach to teach students whereby students passively acquire knowledge. This approach lacks feedback interaction between

teachers and students, and leads to low student motivation for study [1]. Over half a century ago, problem-based learning (PBL) and team-based learning (TBL) were proposed by educators [2]. PBL was first developed in 1969 [3, 4] and has been applied in higher medical education in China since the 1980s [5]. For current innovation in Chinese basic medical education, PBL has been extensively applied as an experimental teaching method in Chinese medical education. It is now accepted worldwide that PBL can greatly benefit students, particularly for training clinical thinking, developing teamwork, increasing acquisition and retention of knowledge, enhancing subject interest, and improving the ability to learn independently [2, 6–10]. However, it is a highly controversial issue whether PBL is better than LBL for acquisition of theoretical and fundamental knowledge, as based on scores in tests of basic knowledge [2, 5, 11–14].

TBL, applied in some medical colleges in China, has also been proposed as an educational approach that retains the education strengths of PBL and achieves these in a more efficient way [2]. Like PBL, TBL encourages students to work together to solve profession-related problems and promotes clinical thinking [2, 15]. TBL has been implemented in many schools as an instructional method that makes students well-prepared for professional practice [16].

Both have become two mainstream approaches in basic-medical education [17]. Moreover, several studies have advocated combining these two approaches [2, 16]. However, PBL is a student-centered approach and students need to generate the learning issues on their own, whereas TBL is a learner-centered, teacher-directed instructional approach and the professors or course directors determine the study content [16]. In TBL, the professor facilitates the discussion among several groups in the classroom. In PBL, one professor leads one group's discussion in the discussion room [2]. Few articles have compared the effects of these two teaching approaches in Chinese basic-medical curriculum. For improving these two approaches for adapting to Chinese medical education, this article compared the differences between PBL and TBL, on student learning and their final academic scores, and collected the opinions of students on their basic medical curriculum for the clinical medicine program.

Methods

Homeostasis module

In China, medical education involves a 5-year undergraduate program that includes basic medical curricula, involving information relevant to human cellular and molecular structure and function. These lessons are aimed at laying a solid foundation for clinical studies and to develop the student's ability to apply basic knowledge to the profession. Module teaching, including the homeostasis module, has been used in Chinese basic medical education. The homeostasis module, taught in the 3rd year, is one of the most important components of the basic medical curriculum. Students study normal physiological structure and function, pathological mechanisms, symptoms and treatments of important diseases related to the urinary system and endocrine system in this module, which contains basic knowledge of physiology, pathophysiology, pathology, pharmacology, chirurgery and internal medicine. Through

studying and applying basic medical knowledge, the ability to reason medically and think clinically can be fostered and trained by linking basic-medical education with clinical medicine.

Sampling and participants

Problem-based learning class

PBL is a student-centered learning approach. In this class, students were divided into small groups equally and randomly, containing 5-7 students per group. One professor in each group facilitated the student discussions. During the initial discussion, students were given a case, written by professors and doctors, and allowed to work together to raise problems that were professionally relevant. During individual self-study, all group members studied relevant knowledge through textbooks and up-to-date articles to solve the same problems raised by the discussions. After self-study, the group reconvened to share the information they found to solve the problem. At the end of the session, the professor gave feedback on the discussion, case and performance of each member in the class.

Team-based learning class

TBL is a learner-centered, teacher-directed instructional approach, in which each class contained small groups of 3-5 students. Before the class, students needed to read the relevant assignments prepared by the professors or course directors. At the beginning of class, each student was given a quiz based on required basic and clinical knowledge. After finishing, students could discuss their own answers with their teammates to reach a consensus and post the team answers. Next, the professor organized a discussion aimed at solving the controversial questions. In addition, the professor helped students to solve the remaining problems after discussion. At the conclusion of class, each student provided written feedback on the quiz, professor and teammates online to professor.

Data Collection and Analysis

Student questionnaire

Two questionnaires, respectively related to PBL and TBL, were distributed to the ALC students after their 3rd year, i.e. upon finishing the homeostasis module. Likert scale statements (with 5 levels, 'strongly disagree', 'disagree', 'neutral', 'agree' and 'strongly agree') were used to collect the students' opinions about their experiences in PBL and TBL on their basic-medical curriculum for the clinical medicine program. Open questions were used to ask students for the best and hardest features of PBL and TBL. The questionnaire was adapted for getting student feedback about their class experiences from a questionnaire previously designed by Thompson et al. [18].

Academic scores

Each grade level used the same final examination, which included questions involving memorization, such as basic knowledge questions, and clinical application, such as clinical case-analyzing questions. In the final examination for Year 4 students at their 3rd year, there were 70 multiple-choice questions, including 52 questions testing memorization and 18 questions testing clinical application, as well as essay questions, including 3 questions testing memorization and 1 question involving clinical application. For the final examination for Year 3 students, there were 80 multiple-choice questions, 32 questions involving required memorization and 48 questions concerning clinical application, as well as 2 essay questions that concerned clinical application.

Data analysis

Quantitative data were statistically analyzed using IBM SPSS Statistic 20. In quantitative data, if the data were normally distributed, a t-test and mean were used. Otherwise, a nonparametric test and median were used.

Ethics approval

This study was approved by Shantou University Medical College.

Results

In total, 13/13 (100%) Year 3 ALC students completed the questionnaire about PBL, and 10/10 (100%) Year 4 ALC students completed the questionnaire about TBL. All academic scores were collected, including 137 from the Year 4 LBL class, 10 from the Year 4 ALC class, and 202 from the Year 3 LBL and 13 from the Year 3 ALC.

Findings from Academic Scores

Scores for the final examinations for Year 4 and Year 3 ALC students are shown in Table 1. In all, neither Year 4 nor Year 3 students showed any significant differences for TBL or PBL compared to LBL ($p > 0.05$). Similarly, when multiple-choice questions, involving memorization and clinical application, were separately analyzed, neither TBL nor PBL showed significant differences with LBL ($p > 0.05$). However, regarding the four essay questions in the 2015 final examination, ALC students did not show an obvious advantage over LBL students ($p > 0.05$), but in the clinical application questions, Year 3 PBL students received higher scores than LBL students ($p < 0.05$) (Table 1).

Table 1
The outcomes about final examination of Grade 2015 and 2016

	2015			2016		
	LBL	TBL	P	LBL	PBL	P
Overall average	64.95	66.45	0.635	59.65 ± 10.42	63.71 ± 7.36	0.153
Accuracy of multiple-choice questions (%)						
Testing memorization questions	71.91 ± 0.22	70.62 ± 0.25	0.469	65.53 ± 0.22	68.97 ± 0.27	0.444
Clinical application questions	66.78 ± 0.21	70.19 ± 0.23	0.232	65.88 ± 0.19	64.73 ± 0.27	0.730
Scores of essay questions						
Testing memorization questions						
NO.1	3.30 ± 1.13	3.64 ± 1.25	0.183	-	-	-
NO.2	3.31 ± 2.04	3.27 ± 1.85	0.903	-	-	-
NO.3	5.10 ± 2.03	6.18 ± 2.79	0.249	-	-	-
Clinical application questions						
NO.1	3.85 ± 0.65	4.18 ± 0.60	0.088	3.54 ± 1.30	4.07 ± 0.62	0.031
NO.2	-	-	-	3.33 ± 2.70	5.92 ± 2.89	0.002

Findings from the Questionnaire

Student response to feedback in PBL and in TBL

Feedback about TBL from the Year 4 ALC can be seen in Fig. 1. Feedback about PBL from the Year 3 ALC can be seen in Fig. 2. Among TBL students, 70% agreed or strongly agreed that they were “Enjoyed the discussions in TBL”, compared to 62% in PBL (Fig. 1, item 1). About learning motivation and interest, 70% of students in TBL and 92% of students in PBL agreed or strongly agreed that active learning “increases my learning motivation and interest” (Fig. 1, item 5). Both in TBL (50%) and in PBL (92%), students agreed or strongly agreed that they “liked the study goals designed in TBL/PBL” (Fig. 1, item 8) (Figs. 1 and 2). When it came to examination, the questionnaire asked the students’ opinion about the effects of

TBL/PBL on their final examination. Most students did not know whether “Useful to my final examination” (TBL:60%, PBL:38%, Fig. 1, item 4). However, 69% agreed or strongly agreed that learning basic knowledge was well suited for PBL, whereas 40% thought TBL was well suited for learning basic knowledge (Fig. 1, item 2). Not only TBL (90%) but also PBL (77%) was useful for clinical thinking, such as questions of clinical application in an examination (Fig. 1, item 3). Regarding study burden, 40% of the students in TBL and 46% in PBL agreed or strongly agreed that active learning “added to my study burden” (Fig. 1, item 6). In TBL, 50% agreed or strongly agreed that the teachers were more helpful, compared with 31% in PBL (Fig. 1, item 7) (Fig. 1 and Fig. 2).

Table 2
Students' view regarding PBL and TBL features

	PBL	TBL
This approach can develop students' ability, such as		
critical thinking	92.31%	70.00%
team-working skills	76.92%	90.00%
leadership	46.15%	20.00%
communication skills	84.62%	60.00%
professional ability	46.15%	30.00%
clinical thinking	100.00%	80.00%
others	0.00%	20.00%
Most useful aspects of this approach, such as		
developing studying interest	7.69%	20.00%
getting the answers directly from the teachers	7.69%	50.00%
improving ability of expression	7.69%	10.00%
helping to understand professional knowledge	46.15%	20.00%
developing ability of self-study	23.08%	0.00%
others	7.69%	0.00%
Most different aspect of this approach, such as		
differences between cases and contents in the book	23.08%	10.00%
time limitation in the class	0.00%	40.00%
time limitation in self-study	0.00%	10.00%
varying quality of cases	76.92%	40.00%
others	0.00%	0.00%
"Analyzing, synthesizing and solving problems" is another ability that some students think can be trained by TBL.		
"Learning mechanism and developing clinical thinking" is another useful aspect in PBL.		

The students' views on the features of PBL and TBL are shown in Table 2. The students thought clinical thinking, critical thinking, communication skills and team-working were trained well in these two approaches, with clinical thinking ranking first in PBL and team-working first in TBL. In addition, some

students (20%) considered the ability to analyze, synthesize and solve problems to be well trained through TBL. In PBL, 46.15% of students viewed that this approach was helpful for understanding professional knowledge. Some students (7.69%) also listed “Learning mechanism and developing clinical thinking” as another advantage of PBL. The cases used in class vary in quality. Those with low quality pose difficulty for study (76.92%). When it came to TBL, students reported that the instructor’s help in class was the most popular aspect (50%). Time limitation and cases with low quality were the most difficult aspects for them (40%) (Table 2).

The questionnaire also asked for the students’ opinion about which approach they preferred to study in this module. Most students (69.23%) in PBL preferred PBL, whereas some students (30%) in TBL chose TBL (Fig. 3).

Time students spent in PBL study and TBL study

The time students spent preparing for TBL/PBL can be seen in Fig. 4. Most TBL students (80%) spent 1 to 3 hours preparing for each lesson, while most PBL students (76.92%) spent 4–6 hours collecting materials and preparing for each case (Fig. 4).

Discussion

This study compared the PBL and TBL students’ views and their academic scores in Chinese basic medical curriculum homeostasis module and observed the following differences.

TBL and PBL are popular among students

Although Janneke pointed out that a certain incongruity between Chinese and Western cultures, such as a traditional secondary education, a hybrid curriculum and examination content, complicates the straightforward transfer of the new teaching approaches to such cultural contexts [19], our results show both PBL and TBL were popular among students. These results are similar to a previous study showing PBL and TBL could motivate students to study. Considering the characteristics of these two approaches, we speculate that the results may be due to the following reasons. Chinese students have used the LBL teaching model for more than 10 years since their primary education, and the new teaching approaches are a novelty that has greatly stimulated students’ interest in learning [5]. Harun et al. pointed out that three components affected students’ motivation to study: the importance of the task, the student’s ability to perform the task and their emotional reactions to the task [20]. Based on these three aspects, students were no longer given lectures during TBL and PBL. On the contrary, they worked together, exchanged their opinions and solved the problems. Therefore, they have more freedom, which would add to their motivation to study [20].

Effects of TBL and PBL on learning outcomes

Previous studies found that students receive higher academic scores due to these active learning approaches [5, 21]. From our questionnaire, most students did not know whether these two approaches were appropriate for passing the final examination. However, students thought that TBL/PBL was useful for basic knowledge and clinical thinking. We speculate that the results may be due to the extra textbooks and articles in these two approaches. Comparing with LBL class, students in PBL and TBL think that these two approaches requires them to read some up-to-date articles and textbooks which are not included in the final examination but can help them to learn more basic knowledge and train their clinical thinking.

Contrary to foreign studies [11, 21-23], in our study neither TBL nor PBL students showed any advantages on academic test scores and memorization questions, as compared with LBL students. This could be explained by differences in higher medical education between China and the West [5]. One of the most important differences is the diversity of reference textbooks in western countries. Most Chinese medical colleges prefer to use the same books across the country, whereas medical colleges in western countries do not use uniform textbooks or standard lecture formats [5]. In this study, the TBL and PBL students used the same references as LBL students. Before the final examination, all students would have reviewed the same basic knowledge. Furthermore, some articles pointed out that the evaluation of the effectiveness of these two approaches were still unsophisticated, particularly for basic medical education [5, 24]. In medical education in China, theory courses often occupy the most teaching time, with the largest proportion of learning contents in the final examination, which cannot completely evaluate students' learning ability in PBL and TBL [5, 24]. Therefore, a more relevant assessment system should be implemented, such as adding laboratory course examinations [5]. Although academic test scores did not show any differences with LBL, we still think that motivation, increased by PBL and TBL, can be life-long and in the long run would benefit student to future learning.

Even though in TBL there were no differences from LBL, students taught by PBL received higher scores in clinical questions. Considering the differences between TBL and PBL, the following reasons may explain the results. Although TBL is an active learning approach and motivates students, it is a teacher-directed instructional approach, which means the teacher, rather than students, decides the learning content. PBL is a student-centered approach in which students generate issues according to what they do not understand [16]. In this aspect, students study and improve on an individual basis in PBL. In addition, PBL presents advantages with respect to improving student abilities in clinical thinking [6-8]. Compared with lecture notes (such as PowerPoint presentations) in the LBL and the tests designed by professors in the TBL, PBL students use clinical cases, adapted from real patients, which is closer to the clinical situation and could better train clinical thinking.

The burden of TBL and PBL

From the student feedback, there are no significant differences in study burden between PBL and TBL. However, we could see that students usually spent more time preparing for PBL than TBL. The

characteristics of these two approaches determine these differences. Students in TBL just need to understand the assignments and textbooks, whereas in PBL students not only are required to assimilate knowledge in the textbooks, but also research information about medical situations and updated clinical principles online, which increases the student burden [16]. Furthermore, it was proposed that during PBL additional work between cases and exploration of blind methods seemed like busy work to the learners [25]. Some students in PBL, especially **lowerclassmen**, spend a large amount of useless time searching information blindly rather than assimilating knowledge or training abilities. Therefore, it is necessary for medical schools to implement **a tailor-made courses of study for lowerclassmen** to learn how to increase information retrieval effectiveness on basic medical curriculum. On the other hand, apart from developing students' learning abilities, the case writers could give some search material clues to students in PBL to relieve some study pressure.

Effect of instructors in TBL and PBL

Although instructors guided the discussion in PBL, student feedback suggested professors were more helpful in TBL than in PBL, possibly because PBL is student-centered and TBL is teacher-directed, so the professor plays different roles in these two approaches [16]. In PBL, the professor encourages students to discuss topics critically and engages students to raise and solve problems. On the contrary, in TBL, the professor gives a quiz first, facilitates the discussion, and even answers the questions during the class. However, since each discussion group requires one instructor, PBL has the disadvantage of requiring a greater number of professional instructors [26, 27]. On account of limitations on instructor-conditions, teacher training is essential. Salah emphasized that effective PBL instructors required multiple skills that are positively related to their role in large group lectures, which could have implications for recruiting PBL instructors in medical programs [28]. Furthermore, peer teaching seems to be a good way to solve the shortage of teachers. Peer teaching is beneficial for not only student teachers, but also learners [29, 30].

Conclusion

Even though there are differences between Chinese and Western cultures, TBL and PBL are two popular teaching approaches among Chinese medical students in the basic medical curriculum. Furthermore, the PBL teaching approach is more effective in training clinical thinking, while the TBL teaching approach does not add to the study burden of students, and the teachers in this approach play a greater role. However, for Chinese medical students to better adapt to these two teaching approaches, during study, both TBL and PBL need to be adjusted according to the actual situation. The relevant assessment system and teacher training system should be perfected. For ease students' burden, it is necessary for medical schools to introduce the topic, such as literature searching, in the appropriate class.

Study limitations

Because our study was only developed at SUMC, and the selection criteria of ALC students was strict, the sample size was limited. In addition, this study was only conducted in one basic medical curriculum and

did not collect feedback from PBL and TBL teachers. Therefore, further research will enlarge the sample size and collect more data not only from students, but also from teachers, to compare PBL and TBL on the basic medical curriculum.

Abbreviations

PBL

Problem-based learning

TBL

Team-based learning

LBL

Lecture-based learning

ALC

Active Learning Class

SUMC

Shantou University Medical College

Declarations

Ethics approval and consent to participate

This study has been approved by the Research Ethics Committee of Shantou University Medical College. All participants were informed that their participation was voluntary. The study objective was explained to all participants, which was proved by the ethics committee. All online surveys were anonymized and untraceable. No individual subject identifiers were collected.

Consent for publication

Informed consent for publication was obtained from all authors.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

Funding

This study was financially supported by Ministry of Education Humanities and Social Science Project (No. 17YJA740063) and Guangdong Province Education Promotion Project (No. [2018]68) in People's

Republic of China. The funding body did not play any roles in the design of the study, collection, analysis, and interpretation of the data, and writing the manuscript.

Authors' contributions

LX contributed to study design, data collection, data analysis and drafting of the manuscript. CX contributed to data analysis. XX, CM, M, HB, FF, CX contributed to study design and critical review of the manuscript. All authors read and reviewed the final version of the manuscript. All authors read and approved the final manuscript.

Authors' information

LX and XX are all the undergraduate medical students of Shantou University Medical College. HB, CM, M, FF, CX are professors of Shantou University Medical College.

Acknowledgements

The authors would like to acknowledge and thank the students who participated in this research. We thank Stanley Lin for proofreading the article.

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Figures

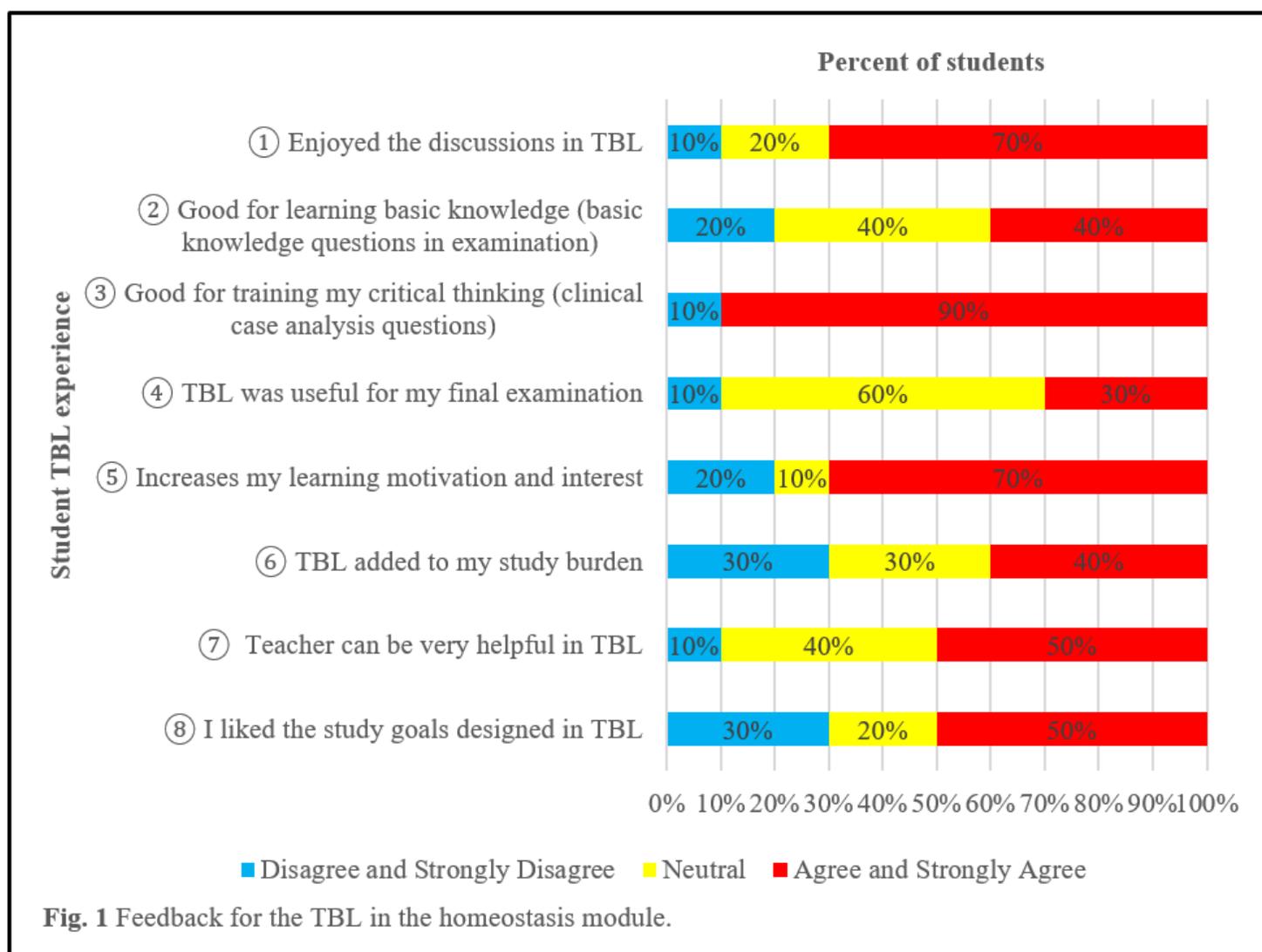


Figure 1

Feedback for the TBL in the homeostasis module.

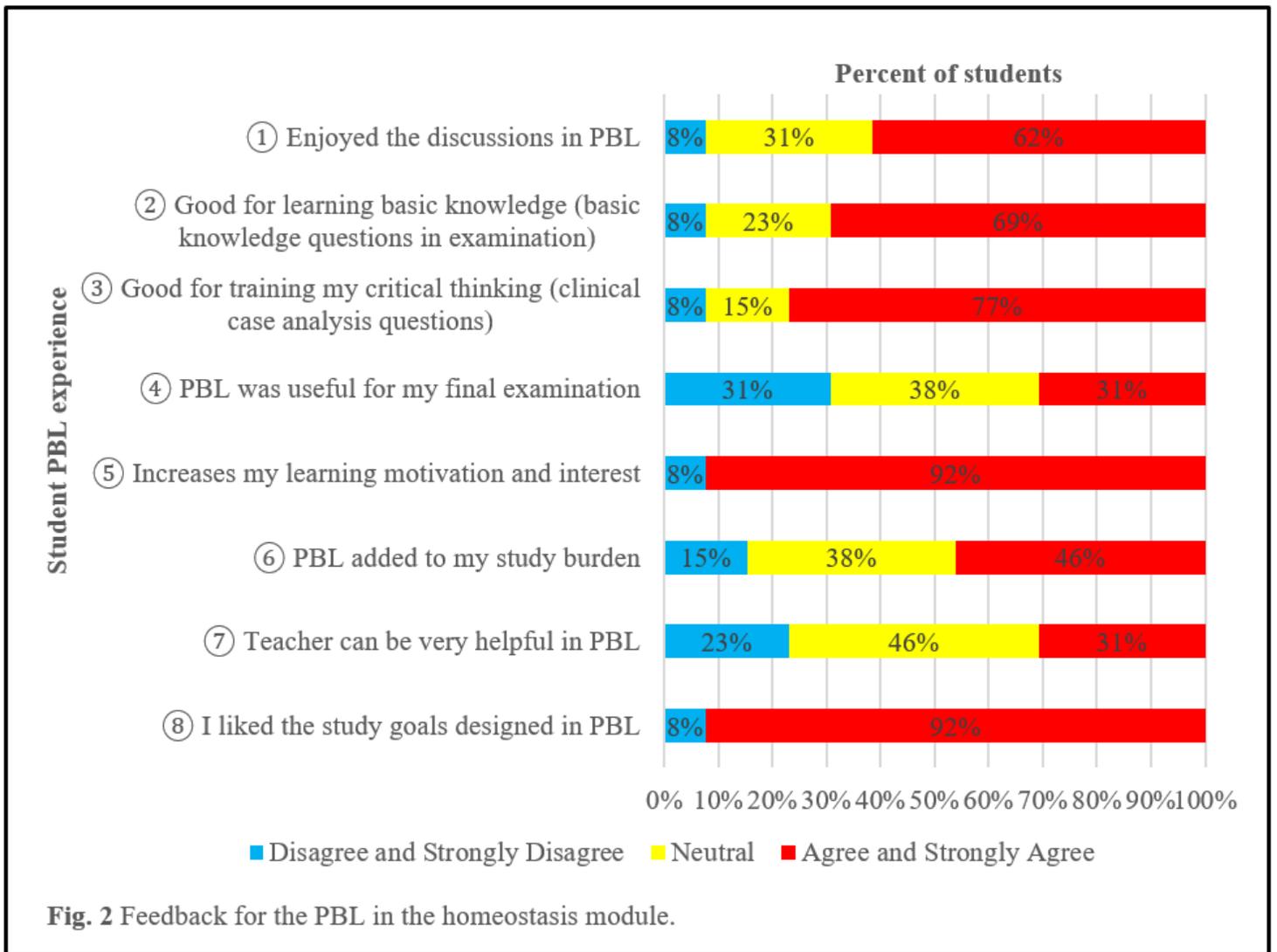


Figure 2

Feedback for the PBL in the homeostasis module.

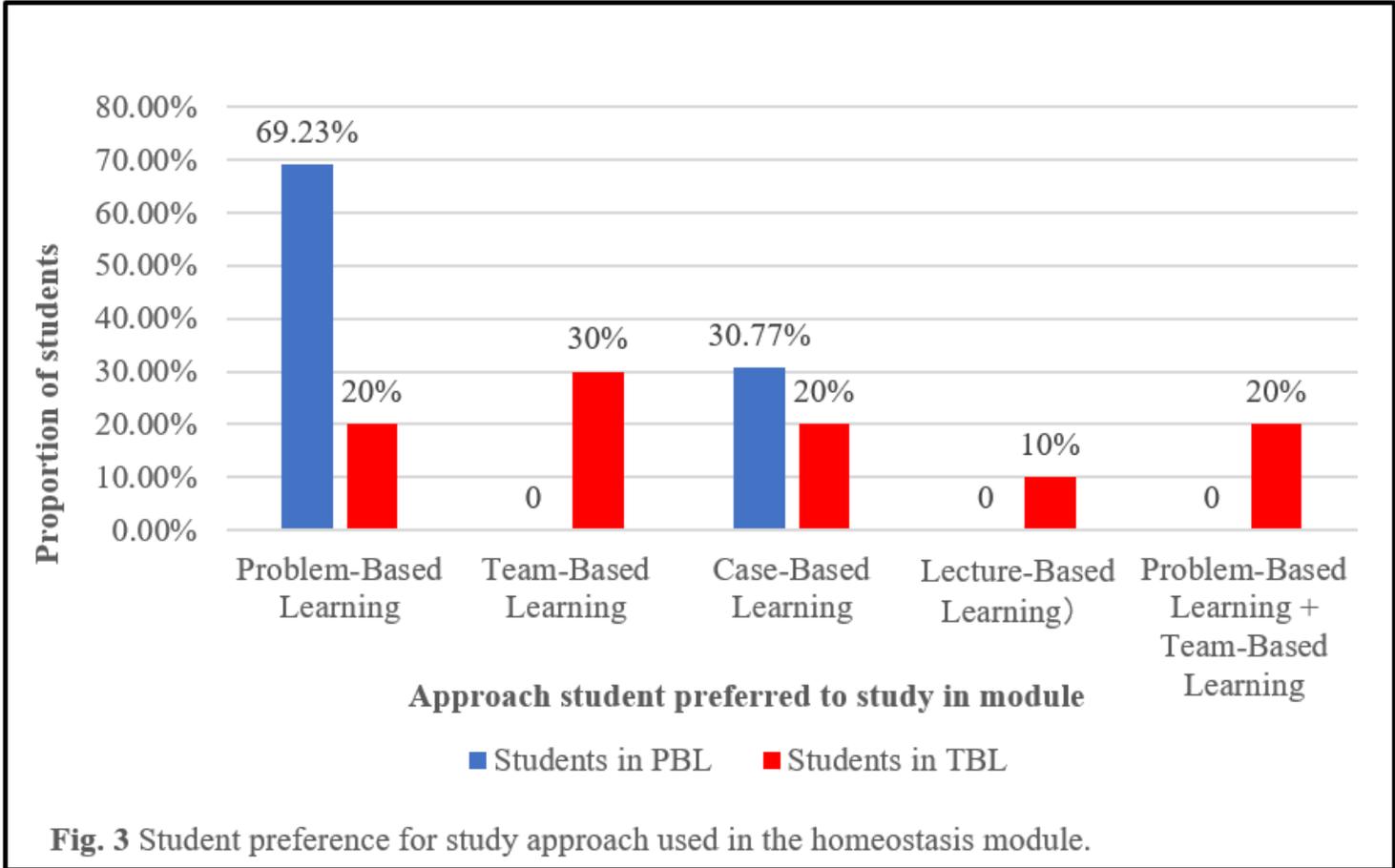


Figure 3

Student preference for study approach used in the homeostasis module.

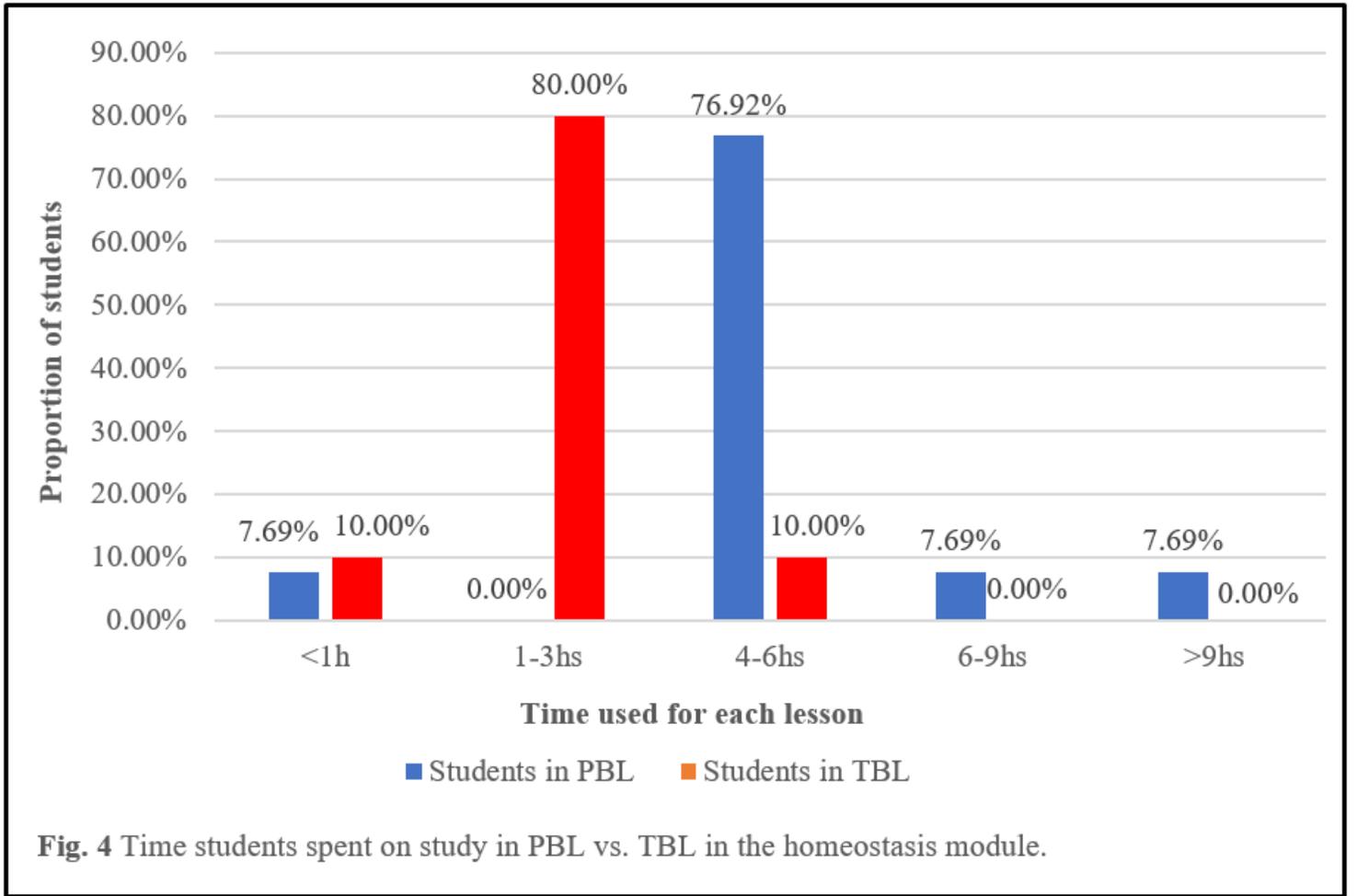


Fig. 4 Time students spent on study in PBL vs. TBL in the homeostasis module.

Figure 4

Time students spent on study in PBL vs. TBL in the homeostasis module.