

# An Observational Study of Team-Based Learning (TBL) and Problem-Based Learning (PBL) in the Teaching of Neuromuscular Disease

**Jingwen Niu**

Peking Union Medical College Hospital

**Jun Zhao**

Peking Union Medical College Hospital

**Ying Tan**

Peking Union Medical College Hospital

**Yangyu Huang**

Peking Union Medical College Hospital

**Yan Xu**

Peking Union Medical College Hospital

**Hui Pan**

Peking Union Medical College Hospital

**Bin Peng**

Peking Union Medical College Hospital

**Yicheng Zhu**

Peking Union Medical College Hospital

**Liyang Cui**

Peking Union Medical College Hospital

**Yuzhou Guan** (✉ [guanyz001@163.com](mailto:guanyz001@163.com))

Peking Union Medical College Hospital

---

## Research Article

**Keywords:** TBL, PBL, Intern, Neuromuscular disease

**Posted Date:** September 1st, 2021

**DOI:** <https://doi.org/10.21203/rs.3.rs-835583/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

---

## Abstract

**Background** To explore the practicability of team-based learning (TBL) and problem-based learning (PBL) in the teaching of neuromuscular disease in the Department of Neurology.

**Methods** During 2012 and 2015, eighty-eight interns from Peking Union Medical College were randomly assigned to the TBL and PBL groups. In the TBL group of 6~8 interns, the teaching process included case preparation, group discussion, oral presentation and teacher assessment. In the PBL group of 24~34 interns, the process included case preparation, oral presentation and teacher assessment. After the teaching process, students were evaluated for basic knowledge, clinical thinking ability, document search numbers and a course experience questionnaire (CEQ); teachers were evaluated based on the effect of class teaching.

**Results** There was no significant difference in the scores of neuroanatomy, neurology, diagnostics, neuromuscular disease or case writing between the TBL and PBL groups before the internship. After the learning process, there was no significant difference in the scores of neuroanatomy, neurology and neuromuscular disease. However, the TBL group performed better than the PBL group in clinical localization diagnosis, literature retrieval ability and inquiry learning ability. Evaluation by teachers showed that there was no significant difference between the 2 groups in teaching objectives, preclass preparation, basic knowledge, integration of basic knowledge and clinical practice, and overall teaching effect; however, the TBL group was superior to the PBL group in class atmosphere, initiative thinking, teamwork and communication between teachers and students.

**Conclusions** Both TBL and PBL could help medical students improve their knowledge of neurology and neuromuscular disease. TBL could better improve students' communication, cooperation, literature searching and inquiry learning abilities.

## Introduction

The course of neurology is relatively difficult to master in clinical practice for medical students, since knowledge of neuroanatomy, neurology and laboratory examination must be mastered and integrated. Clinical neurologists must master basic theoretical knowledge and gain practical experience; however, medical students generally find it difficult to integrate and master the course. Due to its abstract content, neuromuscular disease is rarely discussed and believed to be difficult for students to master in neurology. Traditional classroom teaching is lecture-based learning (LBL). The courses are set in different grades. Medical students in China learn neuroanatomy in the second year of 8-year medical education, diagnostics and neurology in the fourth year and perform neurological internships in the sixth year. Students find it difficult to master and combine the knowledge because of the large time gap between courses. Due to the requirements of the clinical departments, teaching and actual clinical work are disconnected from each other. The curriculum arrangement for medical students is single, and the assessment method is simple. Since various knowledge systems are disconnected, it is difficult to meet the various needs of students and to conduct internships. In recent years, the introduction of problem-based learning (PBL) and team-based learning (TBL) learning modes has been widely recognized in the medical education of many countries. By promoting TBL and PBL in medical teaching, which integrate teaching and clinical work, we aim to explore the effect of simulated clinical teaching methods on interns.

## Object And Method

### 1. Subjects

Medical students who rotated as interns at the Department of Neurology in Peking Union Medical College during 2012 and 2015 were included. The students were at their 6<sup>th</sup> year of eight-year clinical medicine major and had completed the neurology lecture curriculum. According to the facility of clinical rotation and teachers, they were assigned to a TBL group (n=32) and a PBL group (n= 56). The average age was 24.5±1.7 years old, with 45 males and 43 females. There was no significant difference in sex, age or neurology exam scores between the two groups (Table 1).

### 2. Research methods

#### 1) Curriculum:

The curriculum included neuromuscular disease case presentation, neuro-electrophysiology examination visits and group case analysis. There were 30~40 interns rotating for 3~4 months each year from 2012 to 2015.

TBL group: For each batch of interns, 6-8 were in the TBL group. a) Teachers sent cases and learning materials to the students a week prior to class for related knowledge preparation. The learning materials included a list of information to be searched and a video of electromyography examination; b) preclass knowledge examinations were taken, including the Individual Readiness Assurance Test (IRAT) and the Group Readiness Assurance Test (GRAT); c) classroom discussion was held to summarize the characteristics of the cases, diagnosis and treatment progress; 1~2 trainees were responsible for case reporting and characteristics summarizing, 1~2 were responsible for reviewing neuroanatomy, 1~2 were responsible for the localization and diagnosis, and 1~2 were responsible for searching the latest related reviews; d) teachers summarized, answered questions and conducted knowledge assessment and related questionnaires, including the Group Application Problem (GAP) and Final Examination Scores (FESs).

PBL group: For the remaining interns of the same batch, a) teachers sent cases and learning materials to the students one week before class for related knowledge preparation. The learning materials included a list of information to be searched and a video of electromyography examination. b) An oral presentation was given in the classroom by 6~8 students, including the summarization of case characteristics, localization, diagnosis, advances in

treatment, and further inquiry-based learning. Of them, 1~2 trainees were responsible for case reporting and characteristics summarizing, 1~2 were responsible for reviewing neuroanatomy, 1~2 were responsible for the localization and diagnosis, and 1~2 were responsible for searching the latest related reviews. Then, group discussion, reports and questioning were conducted. c) Teachers summarized and answered questions and conducted knowledge assessments and related questionnaires.

## 2) Evaluation system:

Scores of neuroanatomy, neurology, neuromuscular diseases, and case writing were collected. After class, oral examination and questionnaires were used for evaluation. Oral examination, which tested students' basic knowledge and clinical thinking, was recorded by percentile. The questionnaire included teachers and students. The teachers' part included three sections (Table 2): clinical localizing diagnosis thinking, literature retrieval ability, and inquiry learning ability. The total score for each section was 5 points: 5 was excellent, 4 was good, 3 was middle, 2 was not good, and 1 was bad. The students' part included several sections to evaluate the teaching effect (Table 3). Total score for each section was 5 points.

## 3. Statistical analysis

SPSS 22.0 was used for statistical analysis. The measurement data are expressed as the mean  $\pm$  standard deviation, and an independent-sample t test was used. The count data were expressed as a percentage, and the chi-square test or the exact Fisher probability method were used. One-way analysis of variance (ANOVA) and subgroup analysis were used to compare the effects using teacher assessment forms.  $P < 0.05$  was statistically significant.

# Results

## 1. The basic information and score of students.

The sample included a total of 88 students aged 23 ~ 36 years, with a mean age of  $24.5 \pm 1.7$  years; 32 were in the TBL group, and 56 were in the PBL group. No significant differences were found between the two groups in the scores of neuroanatomy, neurology, diagnostics, knowledge of neuromuscular disease or case writing (Table 1).

Table 1  
Baseline score for all intern students (teacher evaluation)

Group	Neuroanatomy	Neurology	Diagnosis	Neuromuscular	Case writing
TBL	85.7	87.7	87.1	83.8	89.9
PBL	87.8	89.3	85.8	85.2	89.3
t	-1.585	-1.746	1.085	-1.771	0.551
P	0.116	0.083	0.281	0.080	0.582
TBL, team-based learning; PBL, problem-based learning.					

## 2. The teachers' evaluation of students after the training program.

There were no significant differences between the TBL group and PBL group in neuroanatomy, neurology or neuromuscular disease scores after the completion of the case discussion. However, the TBL group scored significantly higher than the PBL group in clinical localizing diagnosis thinking, literature retrieval ability, and inquiry learning ability (Table 2), suggesting that TBL might better improve the comprehensive ability of students.

Table 2  
The teachers' evaluation of students after the teaching program.

Group	Neuroanatomy	Neurology	Neuromuscular	Clinical localizing diagnosis thinking	literature retrieval ability	Inquiry learning
TBL	86.8	89.6	88.5	4.13	4.19	4.19
PBL	87.9	89.6	89.1	3.82	3.90	3.89
t	-1.105	0.014	-1.204	2.256	2.237	2.048
P	0.272	0.989	0.232	0.027*	0.028*	0.044*

## 3. The self-assessment of students after the training program.

After the study, the self-assessment forms of the TBL and PBL groups showed that there was no significant difference between the two groups in terms of understanding teaching goals, preclass preparation, basic knowledge, combination of basic and clinical knowledge, problem-solving ability, and overall evaluation of teaching. The TBL group scored significantly higher than the PBL group in terms of active classroom atmosphere, initiative thinking, team cooperation, and communication between teachers and students (Table 3).

Table 3  
The self-assessment of students after the training program.

Group	Clear teaching objectives	positive before class	Active classroom atmosphere	Initiative thinking	Basic knowledge mastery	Teamwork ability	Communication between teachers and students	Combination of basic and clinical	Problem-solving ability	Overall evaluation of teaching
TBL	4.03	4.09	4.22	4.34	4.03	4.22	4.22	4.13	3.91	4.16
PBL	4.09	4.29	3.93	4.04	4.02	3.91	3.90	3.93	4.07	4.07
t	-0.377	-1.375	2.047	2.571	0.106	2.148	2.204	1.347	-1.459	0.649
P	0.707	0.173	0.044*	0.012*	0.916	0.035*	0.037*	0.181	0.148	0.518

## Discussion

TBL is the application of small-group, active-learning methods in which students are held responsible for both individual and group learning. The idea of TBL was originally formulated by Larry Michaelsen in the 1970s<sup>1</sup>. Team learning was also described in 1990 by Senge for the corporate environment, and small-group team learning has been used as an educational tool for several decades<sup>2</sup>. In the book by Michaelsen et al.<sup>3</sup>, the authors offered detailed instructions for how a health profession educational institution may implement this method of learning. They argued that as health professionals, we must work in teams for the best interest of our patients. TBL helps to prepare students to be effective health care providers.

In recent years, TBL has shown better teaching effects than classical LBL and PBL in the fields of microbiology<sup>4</sup>, anatomy<sup>5,6</sup>, neuroscience<sup>7</sup>, genetics<sup>8</sup>, and physical therapy<sup>9</sup>. Before 2016, the TBL teaching method was introduced into the field of ophthalmology. The TBL group achieved better results in IRAT, GRAT, GAP and FESs than the groups using other teaching methods<sup>10</sup>.

We found that in neurology teaching, TBL was better than PBL at making students take the initiative to find learning materials and combine basic and neuroanatomical knowledge with clinical cases. In recent years, the implementation of TBL and PBL has required 1 ~ 2 students responsible for reviewing neuroanatomy using pictures and other models (3-D apps, videos, etc.), making it easy for students to localize nervous system disorders. Especially in the TBL group, neurology knowledge was reviewed and consolidated. Students said that this was the first systematic review course after the study of neuroanatomy, and it enabled them to understand the practical significance of knowledge.

Students in the TBL and PBL groups gained a new understanding of the diagnostic process for neuromuscular disease. A variety of teaching methods, including case analysis and watching videos of neuromuscular disorders and electromyography, could simulate the actual diagnosis process and improve medical students' clinical thinking. Students could also understand "the gap between theory and practice", and the clinical process would neither be strange nor over idealistic for them. For example, when observing in the electromyography room, students found that not all patients had perfect electromyography figures.

The greatest benefit of the TBL group was team spirit and specialization. Because the case analysis involves much knowledge, it would be difficult for one intern to finish. In a team of 6 ~ 8 students, each member had a division of tasks, and they had to cooperate to complete the whole process. The teamwork of 6 ~ 8 students was proven to be most efficient. Although there was no significant difference in the overall evaluation of teaching between the 2 groups (4.16 vs 4.07,  $p = 0.518$ ), the TBL group was superior to the PBL group in classroom atmosphere, initiative thinking, teamwork and communication between teachers and students. Both TBL and PBL have advantages and disadvantages, and it remains unclear which is more suitable for students. One article published in 2017 suggests that students prefer the TBL teaching mode<sup>11</sup>.

The study found that when using the TBL teaching mode, the basic knowledge and clinical thinking ability of interns improved. Clinical thinking and its combination with basic medical knowledge are the foundation of doctors' diagnoses. The teaching is based on actual clinical cases and self-study. Guided to summarize the characteristics of cases and diagnosis, interns participated in the clinical diagnosis and treatment process of real cases and learned the characteristics of abstract neuromuscular diseases. Observing electromyography (EMG) operation helps students understand the relationship between EMG data and neuromuscular dysfunctions, as well as the relationship between the structure and function of the nervous system. These findings are beneficial for both clinical work and research on neuromuscular disorders in the future. In addition, 1 ~ 2 students on the team were assigned a literature review and guideline summarization. This arrangement could train students' ability to retrieve and summarize literature and efficiently save other students' time for other tasks.

Due to improvements in various abilities, medical students were in a mode of continuous inquiry learning after clinical internship and continued to think deeply about clinical problems and published papers during internship<sup>12,13</sup>.

## Abbreviations

TBL: team-based learning; PBL: problem-based learning; CEQ: course experience questionnaire; LBL: lecture-based learning; IRAT: the Individual Readiness Assurance Test; GRAT: the Group Readiness Assurance Test; GAP: the Group Application Problem; FES: Final Examination Scores; ANOVA: analysis of variance; EMG, electromyography

## Declarations

**Ethics approval and informed consent to participate** Ethical approval was granted by the Ethics Committee at the Peking Union Medical College Hospital in accordance with Declaration of Helsinki. All participants gave written informed consent in accordance with Declaration of Helsinki.

**Consent for publication:** Not applicable.

**Availability of data and materials:** The datasets used and analysed during the current study are available from the corresponding author upon a reasonable request.

**Competing interests:** None.

**Funding:** None.

**Authors' contributions:** NJW, data collection and writing of the manuscript. GYZ, study design, data collection and interpretation, and writing of the manuscript. ZJ and PH, interpretation of the data and review of the manuscript. TY, HYY, XY, data collection. PB, ZYC, CLY, supervising and review of the manuscript. All of the authors have critically reviewed and approved the final draft and are responsible for the content of the manuscript.

**Acknowledgements:** None.

## References

1. Michaelsen LK KA, Fink LD. Team-based learning: a transformative use of small groups.: Westport: Greenwood Publishing Group; 2002.
2. PM. S. The fifth discipline: the art and practice of the learning organization.: New York: Doubleday/Currency; 1990.
3. Michaelsen LK PD, McMahon KK, Levine RE. Team-Based Learning for Health Professions Education: Stylus, VA: Stylus Publishing; 2008.
4. McInerney MJ, Fink LD. Team-based learning enhances long-term retention and critical thinking in an undergraduate microbial physiology course. *Microbiol Educ* 2003;4:3-12.
5. Vasan NS, DeFouw DO, Compton S. A survey of student perceptions of team-based learning in anatomy curriculum: favorable views unrelated to grades. *Anat Sci Educ* 2009;2:150-5.
6. Huitt TW, Killins A, Brooks WS. Team-based learning in the gross anatomy laboratory improves academic performance and students' attitudes toward teamwork. *Anat Sci Educ* 2015;8:95-103.
7. Tan NC, Kandiah N, Chan YH, Umapathi T, Lee SH, Tan K. A controlled study of team-based learning for undergraduate clinical neurology education. *BMC Med Educ* 2011;11:91.
8. Ismail NA. Effectiveness of Team-Based Learning in teaching Medical Genetics to Medical Undergraduates. *Malays J Med Sci* 2016;23:73-7.
9. Lein DH, Jr., Lowman JD, Eidson CA, Yuen HK. Cross-validation of the Student Perceptions of Team-Based Learning Scale in the United States. *J Educ Eval Health Prof* 2017;14:15.
10. Huang Z, Li M, Zhou Y, et al. Modified Team-Based Learning in an Ophthalmology Clerkship in China. *PLoS One* 2016;11:e0154250.
11. Burgess A, Bleasel J, Haq I, et al. Team-based learning (TBL) in the medical curriculum: better than PBL? *BMC Med Educ* 2017;17:243.
12. Wang C, Chen S, Feng B, Guan Y. Proteasome inhibitors for malignancy-related Lambert-Eaton myasthenic syndrome. *Muscle Nerve* 2014;49:325-8.
13. Wang C, Guan YZ, Cai QQ, Su W, Zhou DB, Li J. Rapidly Progressive Polyneuropathy in a Patient With Monoclonal Gammopathy: A Case Report of POEMS Syndrome and Beyond. *Medicine (Baltimore)* 2016;95:e3453.