



## Combining Lecture-Based and Team-Based Learning to Enhance Internship Outcomes in Clinical Immunology Practice in a Chinese Teaching Hospital

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**Abstract:** Background: The ongoing COVID-19 pandemic has underscored the critical role of clinical laboratory departments in disease management and highlighted the need for innovative educational strategies to train medical personnel. As clinical laboratory medicine advances towards automation and standardization, there is a growing demand for medical staff who are adept in these new technologies and methodologies. Objectives: his study evaluates the dual-mode of Lecture-Based Learning (LBL) and Team-Based Learning (TBL) in clinical immunology internships within a teaching hospital's laboratory department. The intent is to assess whether this integrated approach can meet the heightened demand for skilled medical staff and enhance the competency of interns in a rapidly evolving field. Methods: Sixty-one interns from Southwest Medical University were randomized into two groups. Group A received traditional LBL, while Group B participated in a combined LBL-TBL program. Their competencies in theoretical knowledge and practical skills were evaluated through assessments and a structured questionnaire. Results: Group B reported significantly higher satisfaction in skills analysis, problem-solving, and clinical operations ( $P < 0.05$ ). Although both groups performed comparably in theoretical knowledge ( $P > 0.05$ ), Group B showed a trend towards improved theoretical understanding. Conclusions: Implementing a dual LBL-TBL mode in laboratory internships fosters better independent learning, analytical skills, and problem-solving abilities. While LBL remains a cornerstone in clinical laboratory education, integrating TBL can further enhance the learning experience and is recommended for broader adoption.

**Keywords:** LBL, TBL, Laboratory medicine, Clinical Immunology, Laboratory Internship

### 1 Introduction

Clinical laboratory medicine in China is an independent discipline composed of clinical laboratory medicine, clinical biochemistry laboratory, clinical immunology laboratory, clinical microbiology laboratory, and other subspecialties. The clinical laboratory medicine is late beginning in China compared with developed countries. In the 1920s, the biochemistry department of Peking Union Medical College was the first to set up the course of clinical biochemistry laboratory. Subsequently, some hospitals in China have established medical laboratories and gradually developed into one of the important sections in hospital - the Department of Laboratory Medicine. In the United States, Japan, Australia and other countries, there is no separate laboratory department, but rather the clinicopathology is used to assist in clinical diagnosis. This is different from that in China, where the pathology department and the laboratory department are independent departments to provide clinical diagnostic evidence. The pathology department focuses on morphological analysis of samples such as tissues, while the laboratory department specialized in data analysis of body fluids and other samples. Nowadays, with the continuous updating of laboratory conditions and equipment, the requirements for the number and quality of the practitioners are also increasing.

The clinical laboratory medicine functions as a bridge between the basic medical science and clinical medicine. With the development of medical modernization, this major gradually became a multi-disciplinary and highly practical discipline, aiming to continuously cultivate higher quality clinical laboratory practitioners. In China, clinical laboratory medicine education includes 3 years of on-campus theoretical study and 1 year of indispensable clinical internship for medical students [1]. The purpose of the internship is to enable students to combine theory with clinical practice, and adapt to the role from medical students to clinicians, as well as the future working environment more quickly[2]. Eventually, they will become the modern applied professionals with solid foundation, practical ability, scientific research thought and high comprehensive quality.

Clinical immunology laboratory is one of the main courses of clinical laboratory technology[3]. In order to adapt to the changes in the teaching connotation of this major, and also to meet the requirements of laboratory technologist training in

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the new era, it is hoped that students could master the methods, principles and the corresponding experimental skills of clinical immunology laboratory. However, owing to its complex, abstract and logical content[4], students have weak basic knowledge in the learning process, and unable to combine clinical practice with theory in successive internship, resulting in poor teaching effects in practice. Meanwhile, the experiments involved in this course are mainly manual operations. Due to the limitations of teaching arrangements, equipment, places and funds, it is difficult to achieve the expectant level of experimental teaching at college. The clinical immunology subgroup, as one of the most manual subgroups in the routine work of the laboratory department in the Affiliated Hospital of Southwest Medical University (China), it is challenging for both the students and teachers. Therefore, it is crucial and difficult to think about improving the existing practice teaching mode and finding a more effective method.

Lecture-based learning (LBL) is a traditional teaching mode, which is mainly by instructors interpreting. It was firstly implemented by the American Medical College and American Medical Association in 1894[5]. Still, LBL is widely used in medical education in China and remains one of the irreversible teaching modes[6]. This 'cramming' teaching method also has some defects, for instance, ignoring students as the main object, limiting the development of students' own ability and is also not conducive to mobilizing students' initiative and enthusiasm[7]. Therefore, we are constantly exploring the new teaching method to make up for the deficiency of traditional teaching mode.

Team-based learning (TBL) was proposed by Professor Larry Michaelsen at the University of Oklahoma (the United States) in the late 1970s and officially utilized in 2001[8]. As a team-based teaching mode, the advantage of TBL teaching mode is to allow students to play the cooperative ability to complete a topic, stimulate students' initiative and enthusiasm for learning, and cultivate students' teamwork ability[9]. Currently, the teaching mode has also been involved in many fields of higher education, including nursing, clinical medicine, pharmacy, veterinary medicine and medical residency. Moreover, the TBL teaching mode plays an effective role in medical education. Through internship and teaching practice in pathology[10], nursing,[11] stomatology[12], and medical anatomy[13], most students believe that the teaching mode could increase the enthusiasm of learning and work, and develop the analyzing skills and problem-solving capacity. As the TBL teaching mode is rarely applied in clinical practice of clinical laboratory technology in China. Lian-Hong Yang et al [14]found that the application of LBL-TBL dual-track teaching could significantly improve the learning outcomes and the follow-up clinical practice during the psychiatric internship. Therefore, teaching hospitals could refer to the contents of different teaching models and think about applying the LBL-TBL dual-track teaching method (Figure 1) into the clinical internship of immunology subgroup in the laboratory department, so as to provide a more suitable and efficient teaching method for the future clinical practice.

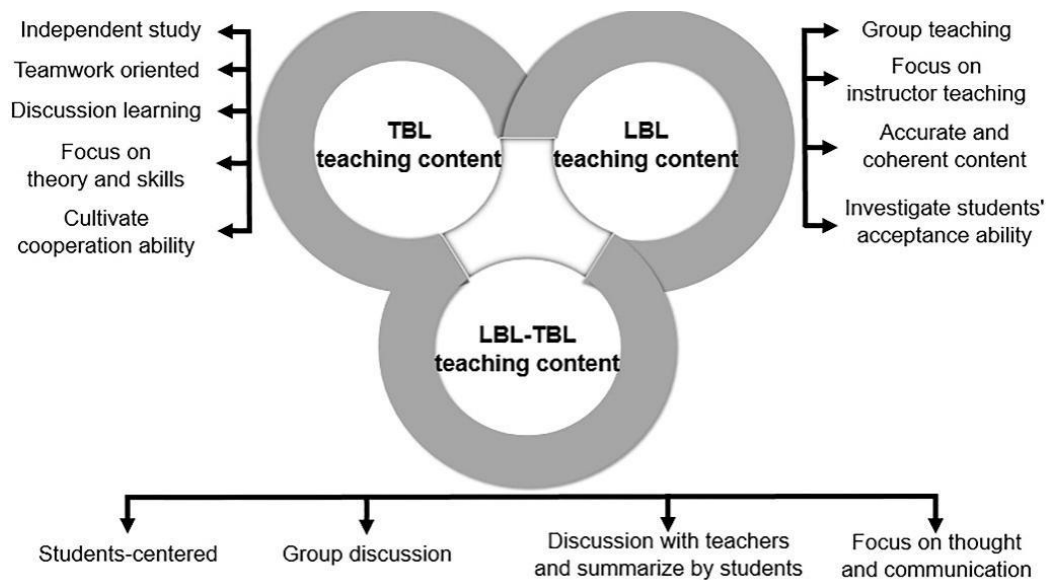


Figure 1. The teaching content of TBL, LBL and LBL-TBL mode.

## 2. Materials and methods

### 2.1. Participants

This investigation involved 61 clinical laboratory technology interns from Southwest Medical University, who had completed prerequisite coursework and were prepared for an immersive clinical experience.

### 2.2. Study Design and Method Selection

The study design was a randomized controlled trial, a method chosen for its strength in comparing interventions' effectiveness. Participants were allocated into two groups: Group A, which followed the traditional LBL method, and

Group B, which followed a hybrid LBL-TBL mode. This design was selected to directly compare the established method with a newer, potentially more interactive approach.

### 2.3. Intervention Details

Group A engaged solely in LBL, a method emphasizing instructor-led teaching and individual learning. In contrast, Group B participated in a combined LBL-TBL program that maintained traditional lectures while integrating TBL's collaborative learning strategies. The choice of TBL for Group B was informed by literature suggesting its benefits in promoting critical thinking, problem-solving, and team collaboration skills.

### 2.4. Teacher requirements

Teachers need to acquire a bachelor's degree or higher, with more than 5 years of work experience and obtain the certification of clinical laboratory, and should also be proficient in theoretical knowledge and relevant experimental operation.

### 2.5. LBL learning mode

The LBL teaching mode was adopted for group A which included theoretical lessons and experimental operation of clinical immunology laboratory. First, the instructors explained and demonstrated the courses, then the students performed experiments and asked questions, and finally the teachers made summaries and conclusions. The teaching form consisted of weekly theoretical lectures and teachers' guidance during daily work (Figure 2).

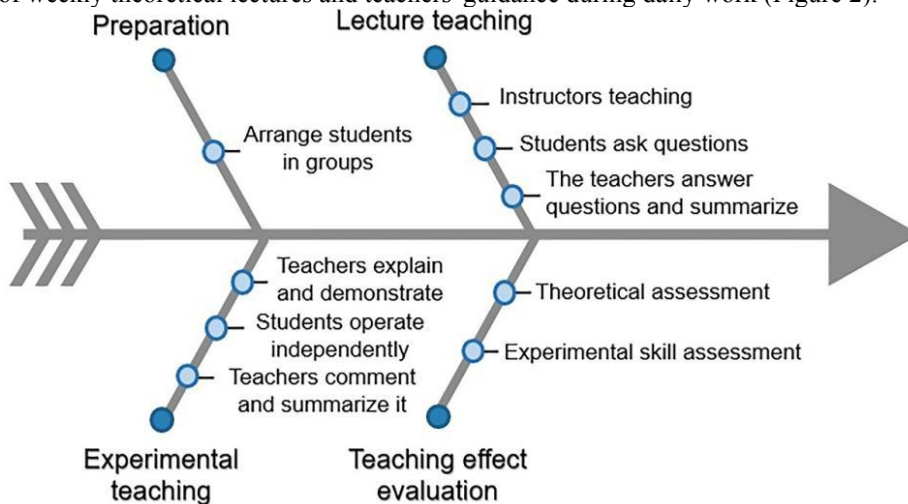


Figure 2. The specific process of the lecture and experimental teaching of LBL teaching mode.

### 2.6. LBL-TBL dual-track learning mode

The LBL-TBL dual-track teaching mode was applied to theoretical and experimental lessons. And the LBL-TBL process included that the teacher assigned the courses (principles, clinical cases, experimental projects) to students via the network platform (e.g. WeChat) before the curricula, and students previewed the teaching

content and collected relevant literatures. During the lecture teaching, the teachers basically construed the content, the group members discussed it and made a report by groups. After the teacher commented on reports, students would summarize it by themselves. As for the experiment teaching, a specific instructor was appointed to lead each group of students. Afterwards, the students completed the experiment together, then analyzed and discussed the problems in the process. Next they communicated with the teachers to further optimize the experimental protocol, and they summarized the clinical significance according to the results. Finally, the designated teacher invigilated operation assessment, and students gave an account of the gains (Figure 3).

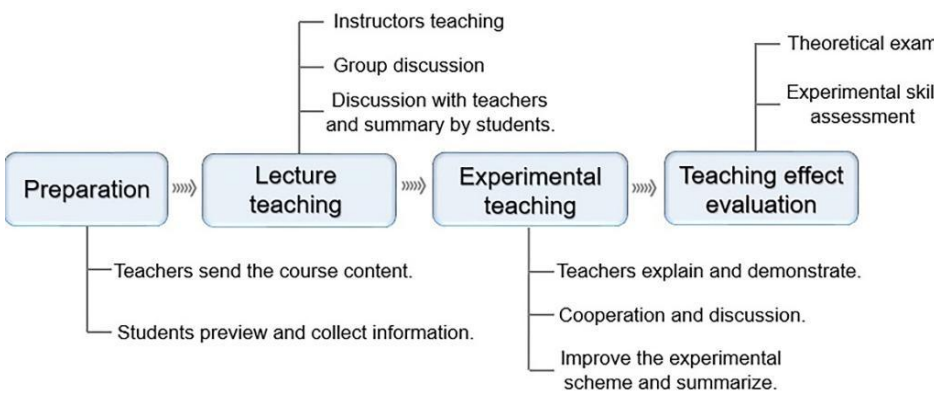


Figure 3. The specific process of the lecture and experimental teaching of LBL-TBL dual-track teaching mode.

### 2.7. Assessment and evaluation of the teaching effect

At the end of the internship, teachers conducted the subject examination (i.e. the theory assessment), and issued the anonymous questionnaire. The questionnaire comprised four

items assessing the capabilities of mastering knowledge, analyzing problems, solving problems, and improving experimental skills during the internship.

### 2.8. Assessment and Evaluation

The teaching effects were measured by a theoretical exam and the responses to the questionnaire, allowing for the quantification of the interns' satisfaction and the perceived impact on their abilities.

### 2.8. Statistical analysis

Data from the survey were performed  $\chi^2$ -Tests to compare the examination results and satisfaction rate by using SPSS ver 23.0.

### 3. Results

#### 3.1. Theoretical assessment

The theoretical assessment scores in the two groups are shown in Table 1. There was no significant difference in the theoretical assessment scores between the LBL teaching mode and the LBL-TBL dual-track teaching mode ( $P = 0.173$ ). This finding implies that both teaching strategies are similarly effective in conveying theoretical knowledge to students.

Group \ Degree	Excellent	Good	Poor	$\chi^2$	$P$
Group A	19	9	3	3.511	0.173
Group B	17	5	8		

Table 1. Comparison of the theoretical assessment scores between group A and B

\* $P < 0.05$  indicates statistical significance

The examination results are divided into three grades: excellent (4-5 correct), good (3 correct), poor (0-2 correct).

#### 3.2. Anonymous questionnaire

Table 2 delineates the satisfaction rates of interns concerning various competencies. Group B, which experienced the LBL-TBL dual-track teaching mode, reported higher levels of satisfaction across key practical skills, such as experimental techniques, analytical abilities, and problem-solving capacities ( $P < 0.05$ ). These practical skills are critical for clinical laboratory technicians, who must accurately perform complex tasks and make informed decisions under time constraints. The statistically significant higher satisfaction in Group B suggests that the integration of TBL may enhance the learning experience by offering more hands-on and collaborative learning opportunities, which are essential in clinical practice.

While the improvement in theoretical knowledge satisfaction did not reach statistical significance ( $P = 0.055$ ), the trend favors the LBL-TBL mode with a satisfaction rate of 60% in Group B versus 35% in Group A. This trend indicates a potential benefit of the dual-track approach that may become more apparent with a larger sample size or alternative evaluative measures. Despite the non-significant P-value, this finding is aligned with educational theories that support active learning strategies as a means to deepen understanding and retention of theoretical concepts.

Furthermore, the LBL-TBL dual-track teaching mode's emphasis on teamwork and discussion may help bridge the gap between theoretical knowledge and practical application, which is often a challenge in professional education. This is supported by current pedagogical research, suggesting that active participation in learning processes can result in a more engaging and profound educational experience.

	Group A		Group B		$\chi^2$	$P$
	satisfied	unsatisfied	satisfied	unsatisfied		
Improve theoretical score	11(35.5)	20(64.5)	18(60.0)	12(40.0)	2.674	0.055
Analyzing problems ability	11(35.3)	20(64.5)	19(63.3)	11(36.7)	4.731	0.030*
Solving problems ability	10(32.3)	21(67.7)	21(70.0)	9(30.0)	8.689	0.003*
Improve experiment skills	13(41.9)	18(58.1)	21(70.0)	9(30.0)	4.867	0.027

Table 2. Comparison of anonymous questionnaires between group A and B

\* $P < 0.05$  indicates statistical significance

### 4. Discussion

At present, the COVID-19 epidemic continues to spread around the world, and the global medical and health system has suffered a huge impact. The spread of the COVID-19 epidemic has also led to a shortage of medical resources. At the same time, medical personnel are also facing unprecedented pressure for preventing and controlling the epidemic, most of all, clinical laboratory technicians have played a key role in COVID-19 diagnosis. In the post-epidemic era, for the sake of

adapting to the rapid development of modern medicine, intelligent equipment and automatic operation of laboratory department. Through reforming the existing teaching mode, improving the medical humanistic quality, and finally cultivating high-quality, skilled, practical talents with professional knowledge and clinical thought.

According to the stage of undergraduate medical education in China, most schools mainly adopt the LBL teaching mode, but only relying on traditional teaching methods cannot meet the needs of modern laboratory talents [6]. Most students believed that the LBL teaching mode did not enhance experimental manipulation, analyzing and solving problems capabilities. Reflects the problem of the traditional LBL teaching mode is that students are passive in the whole teaching process and lack of enthusiasm for independent learning, and then manifested as poor ability to analyze and solve problems [7]. Especially during the internship, students are prone to only know operation, but do not understand its methods, principles, results.

The satisfaction rate of students in the LBL-TBL dual-track teaching group is higher than that of the LBL teaching group in improving their ability to analyze problems, solve problems and experiment operations (Table 2). The main reason is that the LBL-TBL dual-track teaching mode is student-centered compared to the LBL teaching mode, allowing students to active learning through independent thinking and teamwork. At the same time by training students about the capability in experiment, analyzation and solving problems, comprehensively enrich students' knowledge and skills [15]. After the LBL-TBL dual-track teaching mode applied in the internship of the clinical immunology subgroup of the laboratory department, to increase student participation through hands-on operations and group discussions in both theoretical studies and experimental teaching. In view of the problems existing in the experiment process, effectively enhancing students' collaboration, analysis, and problem-solving capabilities, setting up objective, rigorous and dialectical learning attitude for them [16]. Eventually, it consolidated students' medical professional knowledge and cultivated experimental skills, so as to become professional clinical laboratory technicians capable of independent learning, with strong practical skills and clinical reasoning.

Although there is no significant difference between the two groups in theoretical assessment ( $P = 0.173$ ) (Table 1). This may be because both the LBL teaching mode and the LBL-TBL dual-track teaching mode incorporate elements of LBL. The unique advantage of this traditional teaching method is that the instructor logically connects the knowledge and makes a summary, which makes it easier for students to remember and understand. It also proves LBL teaching mode is still essential for students majoring in clinical laboratory technology. Although there was no significant difference in the satisfaction rate of the two groups regarding mastery of theoretical knowledge ( $P = 0.055$ ) (Table 2), the satisfaction rate of group B (60%,  $n = 30$ ) is higher than group A (35%,  $n = 31$ ). It may be caused by factors such as the small number of participants, the single assessment form, and others. Therefore, we consider reforming the current teaching mode by adding participants and ameliorating the assessment form in the subsequent research.

The discussion around the LBL-TBL dual-track teaching mode is bolstered by contrasting our results with previously published studies. The increased satisfaction with the ability to apply theoretical knowledge to practical scenarios, as reported by Group B, aligns with findings from Michaelsen et al.[17]., who documented the benefits of TBL in fostering application and analysis skills in medical education. Our observation that TBL enhances problem-solving abilities is supported by Haidet et al.[18], which found that TBL strategies improve critical thinking among students. This complements our findings of higher satisfaction rates in skills application among interns in the LBL-TBL group. Moreover, the lack of significant difference in theoretical knowledge acquisition between the two groups corresponds with Parmelee et al. (2012), which suggested that while TBL can enhance engagement and satisfaction, it does not necessarily translate into higher theoretical test scores. Additionally, the slight trend towards improved theoretical understanding in Group B, despite not reaching statistical significance, echoes the work of Conway et al. [19], indicating that interactive learning can subtly enhance theoretical retention, perhaps due to the active engagement and contextual application provided by TBL.

It's also worth considering the methodological design of our assessment tools. The questionnaire was developed to gauge the interns' perceived improvement in capabilities that are directly relevant to their future roles as clinical laboratory technicians. However, we acknowledge that self-reported measures have limitations and future studies could benefit from incorporating objective performance metrics to complement the subjective data collected.

In conclusion, this study adopted the LBL-TBL dual-track teaching mode to instruct clinical laboratory technology students during internship in the clinical immunology subgroup of the laboratory department. The preliminary data from this study indicate that the LBL-TBL dual-track teaching mode is a promising approach to clinical laboratory education, potentially offering a more holistic and engaging learning experience that aligns with the demands of the profession. We found that this teaching mode played a positive role in the internship, and affirmed the significance of the LBL teaching mode in the theoretical teaching. Furthermore, the LBL-TBL dual-track teaching method can effectively strengthen students' comprehensive quality like learning and experimental skills, also providing new ideas for internship in the laboratory department.

## 5. Conclusion

The study's findings indicate a clear advantage of the combined LBL-TBL teaching mode over the traditional LBL approach in the clinical immunology laboratory internship. Specifically, interns in the LBL-TBL group demonstrated a

marked improvement in satisfaction with their ability to apply theoretical knowledge in practical settings, to engage in problem-solving, and to conduct clinical operations. Although there was no statistically significant difference in the acquisition of theoretical knowledge between the two groups, a higher trend towards satisfaction with the dual-track method suggests an enhanced overall learning experience. This study substantiates the LBL-TBL mode as a more effective approach to clinical laboratory education, particularly in fostering independent learning and critical thinking skills essential for modern laboratory practices. It is recommended that such a dual-track teaching model be considered for broader implementation to better prepare interns for the challenges of a rapidly evolving healthcare landscape.

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