

# Effective Strategies of PBL Teaching Mode in China's Higher Education

Hanfei Li<sup>1</sup>, Ziqing Lu<sup>2</sup>, Houjin Wu<sup>3</sup>, and Xiang Zhang<sup>4(⊠)</sup>

 <sup>1</sup> School of Environmental Sciences, Nanjing Xiaozhuang University, Nanjing 211171, Jiangsu, China
 <sup>2</sup> School of Foreign Languages, Guangdong University of Foreign Studies South China

Business College, Guangzhou 510545, China <sup>3</sup> School of Education and Languages, Hong Kong Metropolitan University, Hong

Kong 999077, China <sup>4</sup> Department of Otolaryngology Head and Neck Surgery, Shenzhen University General Hospital, Shenzhen 518071, China

zhangxiang@szu.edu.cn

**Abstract.** Problem-based Learning (PBL) method has been applied to different levels of education since its promotion worldwide. Many case studies have proved the effectiveness of PBL method in multiple disciplines. However, there are few studies focusing on the effective PBL teaching strategies in China's higher education. Through case analysis, comparison, critical thinking, and summary, this paper summarizes six effective strategies in the process of PBL teaching in China's universities. They are group cooperative learning, metacognition, four combining modes of PBL and other teaching modes, including LBL, TBL, network teaching mode, and CBL. All these strategies contribute to ensuring the student-centered teaching mode and construct a situational, autonomous, and cooperative learning environment for students.

Keywords: PBL  $\cdot$  Group cooperative learning  $\cdot$  Metacognition  $\cdot$  Combined teaching modes  $\cdot$  Effective strategies

## 1 Introduction

Problem-based Learning (PBL) is an instructional approach that has been used successfully for over 30 years and continues to gain acceptance in multiple disciplines [1]. In PBL, students work in small collaborative groups and learn what they need to know to solve a problem [2]. Then, the adoption of PBL expanded into elementary schools, middle schools, high schools, universities, and professional schools [3]. The biggest advantage of PBL is the focus on student-centered teaching, which advocates setting learning contents in complex and real situations, allowing students to solve authentic problems through cooperation, acquiring scientific knowledge behind problems, finding solutions to problems, and cultivating the ability of independent learning.

H. Li, Z. Lu, H. Wu and X. Zhang—Contributed equally.

Studies mainly concentrate on students' performance and attitude toward PBL, the acquisition of metacognitive skills in PBL, and the factors that affect PBL as well as PBL theory and its application prospect, reform and real-class practices. Results from abundant real-class case studies in universities prove the effectiveness of PBL strategies in the process of teaching. All these studies show that PBL is more in line with the requirement of higher education and the need for social talent training. However, there are rarely relative systematic review papers on the effectiveness and role of PBL teaching mode in China's higher education. Therefore, this paper carries out an overall review based on a large number of relevant journal papers, books, and documents by using case analysis, comparison, critical thinking, and summary. The main body concludes three parts and the first part discusses the effectiveness of the basic group cooperative learning strategy. The second part discusses the metacognitive strategy used in Chinese universities and its advantages. The last part summarizes four common combined modes of PBL and other teaching modes. Each teaching mode combined with PBL has its unique characteristics and conforms to the current situation of teaching in China. The discussion of the effectiveness of these PBL strategies echoes the Chinese traditional teaching idea of "teaching according to local conditions and students' aptitude" in making classroom teaching more efficient. Through analyzing effective strategies of PBL in China, this paper aims to provide a systematic conclusion of authentic and practical teaching skills to Chinese higher education teachers.

## 2 Six Effective PBL Strategies in China's Higher Education

### 2.1 Group Cooperative Learning

Group cooperative learning is the basic organizational form of PBL. In a PBL group, students are confronted with authentic problems in real situations. The collaboration of PBL group is essential so that students can become responsible for self-directed learning. Based on the system established by Barrows, the basic process of PBL, which has been proven effectively in medical education, is to form a group, design a problem, organize the discussion, assign tasks, present reports, evaluate and reflect on the problem [4]. It is a practical PBL teaching strategy repeatedly verified by multi-disciplines. Hmelo-Silver pointed out that students work in collaborative groups to identify what they need to learn to solve a problem, engage in self-directed learning, apply their new knowledge to the problem, and reflect on what they learned and the effectiveness of the strategies employed [2].

In medical education, Wang, Min, and Li carried out a comparative teaching study on 83 students majoring in sports medicine at China Medical University [5]. The control group used the traditional teaching mode, and the PBL group used the improved PBL teaching mode. Before class, the instructor prepares four cases in the syllabus, designs teaching scenes, and randomly distributes cases to the PBL groups. The group leader then organizes the members to discuss, summarize and make 10-minute courseware. In class, each group sends a member to give lectures and explanations about the involved cases. After the presentations of each group, students fill in the scoring table based on the standard and their feelings. A questionnaire of students in the PBL group reveals that students' overall evaluation of the course is good, and the evaluation of collaborative group members is very satisfactory. With the same levels of the tutor, the qualification evaluation method, and the credit hours, the results verify the effectiveness of the basic group cooperative learning process of PBL in improving students' self-directed learning ability.

There are many study cases applying the group cooperative learning method in PBL class of higher education. Analysis of abundant studies on the effectiveness and assessment of PBL in other disciplines of higher education further proves that the basic process of PBL is effective. It consists of five interrelated key elements. They are group, problem, discussion, presentation, evaluation, and reflection [6]. In group cooperative learning, students clarify research issues through discussions and mutual assistance and understand the research process through questioning and debate. Discussion prevents students' research from singleness and narrowness, avoids the stagnation of research caused by dispersion, and helps to cultivate team spirit. According to Barrows, a closing analysis of what has been learned from working with the problem and a discussion of what concepts and principles have been learned are essential [1]. The presentation of their study is the integration and summary of students' cooperative works. Students display the concluded results in class to make their research clear and reasonable. Through the presentation, the whole process of group cooperative learning is shown in a precise and continuous way, and students may feel more participating and motivated. Evaluation is the last step of the PBL mode, which aims to make students reflect on their research [7]. It helps to cultivate students' critical spirit and logical thinking ability. Group students can learn from each other, and more importantly, through evaluation, students' awareness of reflection on research is enhanced. However, the mechanical application of PBL is not feasible. The age and learning stage of students and the difficulty and complexity of course content should also be considered in using a group cooperative learning strategy in a PBL class. There should be more flexibility in the selection and setting of problem cases, grouping methods, discussion process, evaluation process, and so on. In this way, the group cooperative learning strategy in PBL teaching mode will be proved effective in multi-disciplines of higher education repeatedly.

#### 2.2 Metacognition

Metacognition is another effective strategy in PBL that focuses on student-centered learning. Metacognition is based on constructivism, and this concept was first proposed by Flavell [8]. Flavell believes that metacognition is the understanding of knowledge and thinking [9]. To explain metacognition simply and directly, it is an individual's self-examination and self-reflection on the process of cognition and accepting knowledge. Metacognitive strategies play a positive role in improving individual problem-solving ability [10]. Individuals can get a more comprehensive understanding and improve their ability to make rapid responses and adjustments to learning projects [11]. At present, the application of metacognitive strategies in colleges and universities includes helping students consciously adjust to the logic of self-cognition and the construction process of the knowledge system [12]. Metacognitive is closely related to the learners' self-regulation, which is such a cycle including three concrete measures: self-planning, self-monitoring, and self-evaluation [13].

### 2.2.1 Self-planning

Self-planning refers to learners' goal setting and task delineation in metacognitive strategies [12]. It is the first step that learners have clearer goals in the subsequent selfmonitoring and self-assessment process. The metacognitive teaching strategy, it is the awareness of making a study plan in students' learning process. Tan pointed out that the first step of project-based learning is to choose appropriate projects [8]. It is pivotal in the self-regulatory processes as well [13]. Self-planning gives students the right to choose the task they are interested in, and students can choose tasks according to their own needs and abilities. It concludes the study schedule, learning objectives, and so on. Li Weidong and Li Ying conducted a study on English Majors in a university [14]. They found that students who can determine reading goals and plan reading can get better reading test scores. This shows that making plans can promote students' learning to a certain extent. Self-planning is fully student-centered, helping learners to carry out personalized learning, cultivating students' self-learning habits, and improving their autonomous learning ability [15].

### 2.2.2 Self-monitoring

Self-monitoring is another important part of the self-regulatory process, which refers to learners' reflection on metacognitive skills, tasks, goals, results, and reflection of experience in the process of project-based learning [16]. Self-monitoring is a strategy that pays more attention to subjective consciousness. It can trigger learners to regulate the learning process, such as allocating self-learning time, effort, and learning resources. Miao studied self-monitoring learning strategies among students majoring in physics in Nanyang Normal University [17]. Through the results of the pre-test and post-test, it was found that students who used self-monitoring strategies to monitor their selflearning status and learning process performed better in the theoretical study of physical education. Research also found that self-monitoring can help students with theoretical learning, mobilize students' participation in studying and improve their ability to solve problems. In general, self-monitoring plays a key role in constructing an individual knowledge system.

### 2.2.3 Self-evaluation

Self-evaluation refers to evaluating learners' learning experience in metacognition [12]. Self-evaluation can provide a way for students participating in PBL to identify individual strengths and weaknesses; it can also enhance learners' self-reflection and learning ability [18]. Liu believes that a self-evaluation scale is an effective tool for self-evaluation. The scale is constructed based on Bloom's goal classification theory. It has been tried out in medical colleges and universities. Researchers found that the scale has good reliability and validity. It can not only stimulate students' learning but also help teachers continuously improve PBL teaching. In other words, self-evaluation is an effective strategy in PBL teaching.

#### 2.3 Combination of PBL and Other Teaching Modes

#### 2.3.1 Combined Mode of PBL and LBL

Lecture-based Learning (LBL) is a traditional teacher-centered teaching mode in large classes taught in an indoctrination style. It takes teachers as the main body of the classroom, aiming to improve teaching efficiency and enable students to obtain the complete knowledge system as soon as possible. PBL focuses on solving problems in complex situations with students as the center to improve their learning motivation. LBL, on the other hand, focuses on the teacher as the main subject in the classroom and aims to increase teaching efficiency and let students acquire a complete body of knowledge as soon as possible. The differences between PBL and LBL are summarized in Table 1. Poon and Kong claim that the students are allotted the same amount of time to study law as in any other subject [19]. They were motivated to study law under this combined mode of teaching because it can enhance their confidence when writing tests and study of legal knowledge. When the two teaching modes are combined, the quality of teaching is improved. As a result, the communication between student and teacher changes from traditional lecture listening to mutual communication. Therefore, the combination of PBL and LBL retains the advantages of PBL with the compensation of an incomplete knowledge system. It deepens students' memory, and mastery of textbook knowledge inspires creative thinking and improves students' ability to learn and solve problems independently. Hence, the dual mode of PBL and LBL is suitable for the current higher education.

#### 2.3.2 Combined Mode of PBL and TBL

Team-based Learning (TBL) is a teaching mode relying on group interaction. Both TBL and PBL are student-centered and have a positive effect on students' development, but there are still some differences which are summarized in Table 2. In practice, the single educational approach is hardly sufficient for the actual teaching work. For example, Zhong, Li, Huang, Cao and Xiao refer that it is difficult to meet the actual teaching content in a single teaching method because of the different objects and contents in the teaching of electronic technology courses [20]. Therefore, the combination of PBL and TBL is adopted widely.

In their study, teachers use PBL in the basic experimental assessment to give experimental design problems, and students need to explore and solve basic theological knowledge independently. But in the comprehensive experimental assessment, students are often required to design a complete and complex experiment. Before that, teachers need to inform students of the requirements and technical specifications of the experiment. However, most students still cannot finish the objective independently. In this case, the teaching mode changes into TBL, and students are allowed to discuss, operate and report in teams. This example shows that PBL is suitable for classes with more theoretical teaching contents, while TBL is suitable for classes focusing on practices. Therefore, the combination of PBL and TBL is the appropriate teaching mode that can be adopted according to the difficulty level of different chapters within a course.

	PBL	LBL	PBL+LBL
Format	Teachers start with a problem to stimulate students problems-solving and learning interests.	Teacher's lecture is the central focus and students receive knowledge passively.	Students study independently before class and teachers answer questions.
Objective	Enable students to produce results through their own investigations and focus on the overall research process.	Help Students to acquire knowledge systematically and improve school scores as fast as they can.	Stimulate students' hands-on and analytical skills while ensuring efficient teaching.
Teacher's role	Designer of teaching models, guide and collaborator of student learning.	Classroom and student leader, the "arbiter" of knowledge.	The classroom facilitator.
Merits	Bring questions into play in guiding the learning process. Mobilize students' initiative and motivation.	Enable students to acquire the more systematic knowledge in depth.	Avoid incomplete learning and increase student motivation.

 Table 1. The Difference and Combination of PBL and LBL

(Table credit: Original)

Table 2. The Difference and Combination of PBL and T	ГBL
--	-----

	PBL	TBL	PBL+TBL
Core value	Inspire students with questions.	Enable students to complete task objectives in social situations.	Allow students to absorb the knowledge through hands-on experience.
Suitable classes	Theoretical.	Practical.	According to the difficulty level of course.
Role of classes	Teacher: Situation setter and supervisor. Students: Participants.	Teacher: Organizer and guide. Students: Team players.	According to the teaching mode.

(Table credit: Original)

## 2.3.3 PBL and Network Teaching Mode

Network Teaching Mode is an Internet-based distance learning mode. With the outbreak of the epidemic, online teaching form has become dominant. Whether using PBL in

class or online, distance learning alone cannot fully meet the current teaching needs. In their research, Li, Yang and Zhang combined PBL with online teaching in their teaching practices [21]. They took acute and critical illnesses as examples in the teaching of traditional Chinese medicine students. By establishing WeChat groups, they provided teachers and students with real-time course recordings on the Internet platform so that students could play back at any time after class. In the online PBL class, students' selfdirected learning ability has been improved by guiding them to ask questions and seek answers. It is conducive for students' sharing information and knowledge. Teachers' teaching methods and students' learning style are enriched both. Their combination combines the advantages of both PBL and online teaching. Despite of low interactivity and unstable network speed equipment, improving teaching process and effect of the network PBL still has more advantages. Students are more willing to accept the combined teaching method that can break geographical restrictions and share superior teachers worldwide. The network PBL is proved an effective measure to improve the quality of online teaching during the current epidemic.

#### 2.3.4 Combined Mode of PBL and CBL

Case-based Learning (CBL) is a clinical case-based pedagogy developed from PBL [22]. It is a results-driven method that focuses on cultivating students' logical reasoning while PBL is problem-oriented that aims to arouse students' subjective initiative in learning. A teaching method that combines the virtues of PBL and CBL can better achieve the goal of promoting effective, high-quality student learning [23]. In Luan, Wang, Zhou, Liu and Wang's article "The Application of PBL and CBL in the Practical Teaching of Pharmacy Students", the pharmacy interns are taught in groups, the observation group is taught in the PBL and CBL joint teaching mode, and the other group is used as a control group to carry out the traditional teaching mode [24]. Through comparison, it can be found that in terms of teaching effectiveness, the theoretical and operational level of the observation group is higher than that of the control group. And the students in the observation group generally believe that the teaching method of PBL combined with CBL enhances their reasoning judgment and independent learning and improves their learning enthusiasm.

The combination of PBL and CBL improves the difficulties that make students feel bored in the traditional teaching mode, enhances the initiative of students' learning, and puts students no longer in a passive position of listening to teachers, especially for the discipline of medicine, which has a short internship period but high professional requirements. PBL and CBL is an efficient and targeted teaching mode that allows students to obtain the greatest mastery of theoretical and practical knowledge in a short period and form a good thinking pattern. However, there are also shortcomings in the application of this teaching mode. The teachers are incompetent due to insufficient teaching experience and unstable teaching resources. It is necessary to pay more attention to development, reduce the restrictive factors of objective conditions, and cultivate more talents for society.

## 3 Conclusion

This review concludes six effective strategies of PBL teaching mode in China's higher education. They are group cooperative learning, metacognitive strategies, the combination of PBL and other teaching modes, including LBL, TBL, network teaching mode, and CBL. Through group cooperative learning, students can learn and evaluate each other to enhance their reflective and evaluative awareness of the subject matter, which is a good method to optimize PBL teaching mode. While using metacognitive strategies, students can significantly improve their learning autonomy and become self-directed learners and independent thinkers when self-planning, self-monitoring, and self-evaluating are shown in their study process. Then, by comparing their strengths and weaknesses, it reviews a series of effective combinations of PBL with other teaching modes. First, the combination of PBL and LBL is proved to be one of the best dual modes for current China's higher education for knowledge can be learned effectively and comprehensively by students. Second, the combination of PBL and TBL can enhance students' hands-on experience and group cooperation ability according to the difficulty of the course. Third, it's conducive for students to view and review information of courses when PBL bonds with the Network teaching mode. Forth, the combination of PBL and CBL contributes to improving students' ability of reasoning, judgment, and independent learning. All these strategies are pioneering methods for strengthening quality-oriented education in China. However, with the development of the new era, the system of contemporary higher education is subject to change at any time, so this paper cannot cover all information about China's higher education. Despite the existing room for improvement in the analysis of effective strategies of PBL, this paper still has its contribution.

## References

- 1. Savery, J. R. (2006). Overview of Problem-based learning: definitions and distinctions. The Interdisciplinary Journal of Problem-based learning, 1, 9–20.
- 2. Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? Educational Psychology Review, 16(3), 235–266.
- Torp, L., & Sage, S. (2002). Problems as possibilities: Problem-based learning for K-16 education (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- Liu, D., & Li, Y. (2014). Analysis of PBL Teaching Strategies. Journal of Liaoning Teachers College (Social Sciences Edition), 4, 75–78.
- Wang, Z.Q., Min, R., & Li, Y. N. (2010). Discussion of PBL method applied in large group of students and its effectiveness evaluation. China Higher Medical Education, 11, 97–98, 110.
- 6. Li, G. Q. (2014). On the construction strategy of problem-based learning (PBL) mode in Teacher Education Curriculum. Education and Teaching Forum, 6, 170–172.
- Wan, Y., & Ding, F.Q. (2017). The practice and reflection of PBL mode in the research of University psychology. Journal of Inner Mongolia Normal University (Educational Science), 30, 67–72.
- 8. Tan, J. (2017). English PBL Teaching Mode and Metacognitive Strategies. Cultural and educational materials, 26, 220–221.
- Dong, Z. S. (2005). Metacognition and Metacognitive Strategies. Journal of Qinghai Teachers College (Educational Science Edition), 25(3), 294–296.

- Berardi-Coletta, B., Buyer, L., Dominowski, R., & Rellinger, E. (1995). Metacognition and Problem Solving. Journal of Experimental Psychology. Learning, Memory, and Cognition, 21(1), 205–223.
- Cho, Y., & Linderman, K. (2019). Metacognition-based process improvement practices. International Journal of Production Economics, 211, 132–144.
- Mao, L. Y. (2020). Exploration of College English Teaching under the Guidance of Metacognitive Strategies. Overseas English (Part 1), (1), 56–57.
- DiBenedetto, M., & Zimmerman, B. (2013). Construct and predictive validity of microanalytic measures of students' self-regulation of science learning. Learning and Individual Differences, 26, 30–41.
- Li, W. D., & Li, Y. (2011). The application of metacognitive strategy training in English reading teaching. Journal of Inner Mongolia Normal University (Educational Science Edition), 24(7), 119–122.
- Cao, Q. Y. (2006). Metacognition and Students' Network Autonomous Learning. Hu'nan Keji Xueyuan Xuebao, 27(9), 202–204.
- Riemer, V., & Schrader, C. (2019). Mental model development in multimedia learning: Interrelated effects of emotions and self-monitoring. Frontiers in Psychology, 10, 899.
- Miao, H. (2007). The influence of self-monitoring ability on the learning effect of physical education theory course. Journal of Nanyang Normal University, 6(12), 86–88.
- Liu, W. W. (2018). Establishment of PBL Student Self-evaluation Scale and Test of Reliability and Validity. Health Professions Education, 36(20), 58–60.
- Poon, J., & Kong, M. (2014). Perception of non-law students on the combined lecture- and problem-based learning approaches. Open Journal of Social Sciences, 2(5), 45–50.
- Zhong, L. S., Li, J. L., Cao, G. F., & Xiao, B. (2013). Combined application of PBL and TBL teaching methods in "Electronic Technology Course Design". China Electricity Education, (08), 53–54.
- Li, Y., Yang, S. P., & Zhang, B. P. (2021). Exploration and Practice of PBL Network Teaching in Traditional Chinese Medicine. Chinese Medicine Modern Distance Education of China, 19(18), 6–8.
- Yang, W. D., Kang, F., Ma, W. H., & Wang, J. (2019). Integrating LBL, PBL, CBL, TBL, RBL and other teaching methods for nuclear medicine teaching. Labeled Immunoassays and Clinical Medicine, 26(10), 1775–1777+1791.
- Zhao, W., He, L., Deng, W., Zhu, J., & Zhang, Y. (2020). The effectiveness of the combined problem-based learning (PBL) and case-based learning (CBL) teaching method in the clinical practical teaching of thyroid disease. BMC Medical Education, 20(1), 381.
- Luan, J. J., Wang, S., Zhou, D. X., Liu, X. Y., & Wang, W. S. (2020). The Application of PBL and CBL in the Practical Teaching of Pharmacy Students. Journal of Wannan Medical College, 39(02), 187–189.

216 H. Li et al.

**Open Access** This chapter is licensed under the terms of the Creative Commons Attribution-NonCommercial 4.0 International License (http://creativecommons.org/licenses/by-nc/4.0/), which permits any noncommercial use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made.

The images or other third party material in this chapter are included in the chapter's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the chapter's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder.

