

PBL Pedagogy in the Chinese Clinical Training: A Meta-analysis Short Title: PBL in Chinese Clinical Training

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Abstract Background: The problem-based learning (PBL) teaching method has been indicated to be more effective than lecture-based learning (LBL) teaching method in the Chinese clinical training. However, the individual studies results were still conflicting. **Objective and methods:** To explore the effectiveness of PBL teaching method in the Chinese clinical training, a meta-analysis including 913 participants from 13 studies was carried out. The random or fixed effect models were used to evaluate the standardized mean difference (SMD) or the pooled odds ratios (ORs) and their corresponding 95% confidence intervals (CIs). **Results:** The PBL teaching method had a positive effect on achieving higher theoretical (SMD=1.04, 95% CI: 0.51-1.56, P=0.0001) and practical scores (SMD=1.54, 95% CI: 1.03-2.06, P=5.54×10⁻⁹) than LBL teaching method in the Chinese pre-clinical training. **Conclusions:** The PBL was more effective in the Chinese clinical training than the traditional LBL teaching method. The application of PBL should be carried out on a larger scale in the clinical education.

Keywords: *problem-based learning, lecture-based learning, clinical, Chinese*

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1. Introduction

Problem - based learning (PBL) teaching model is a novel teaching model which was first implemented by America neurology professor Barrows in 1969 [1]. The PBL teaching method is a student-centered teaching method to discuss the clinical common problems in groups. In the clinical medical education, PBL teaching model proposition is that the problem should be served as the learning starting point to encourage the students to learn the knowledge of solving the problems by themselves and actively analyze the problems and solve the problems ultimately. This kind of teaching model has been widely used internationally and the medical educational model reform is also developing to this pattern in China [2]. Medicine is an integrated discipline which covers relatively wide range. In addition, the speciality, practicalness and integrity of clinical medicine are relatively strong. Hence, it is very difficult for the students to understand, master and digest the knowledge in a short time. The traditional lecture-based learning (LBL) teaching method is a teacher-centered teaching method. The students could only learn passively and lack of the learning motivation and enthusiasm by using the LBL teaching method. Thus the theory and practice are disjointed and the basic skills of clinical operations are not steady in many students. Additionally, the LBL teaching method restricted the creative thinking development and

could not satisfy the modern healthcare organization requirements. While the PBL teaching method attached importance to the cultivation of the student clinical thinking abilities which could make the students put into the study with the best physical and mental state.

As so far, many studies on the effectiveness of PBL teaching method in the Chinese clinical training have been carried out. Hence in this study, a meta-analysis including 458 PBL participants and 455 LBL participants from 13 individual studies was performed to evaluate the effectiveness synthetically. Although some individual studies results were still conflicting with each other in the current study [3,4,5], generally speaking, the PBL was more effective in the Chinese clinical training than the traditional LBL teaching method. The application of PBL should be conducted on a larger scale in the clinical education.

2. Materials and Methods

2.1. Publication Search and Inclusion Criteria

The electronic databases including PubMed, Embase, Web of Science, China Biological Medicine Database, and China National Knowledge Infrastructure were searched by using the terms as "problem-based learning", "PBL", "lecture-based learning", "LBL", "Chinese", "clinical", "education", and "Chinese". The last research was updated on June 08, 2016. The publication years ranged from 2010 to 2016.

The included studies should fit the following major criteria: a) Assessment of the effectiveness of PBL teaching method in the Chinese clinical training. b) PBL teaching method is defined as a student-centered, training the student self-study ability with teachers serving as guiders to reinforce the discussion and assistance abilities in the team and help cultivate the clinical practices creativity [6]. c) The selected studies should be case-control or cohort studies published officially.

2.2. Data Extraction

According to a standard protocol, the information was extracted. The current meta-analysis was performed by three researchers. The retrieval process for the individual studies was duplicately carried out by two researchers, and the third investigator acted as the referee to resolve the branch point between the two researchers. Those studies that deviated from the major selection criteria, that were published tautologically, or that did not provide the sufficient data were excluded from the present meta-analysis. If the analogous data appeared in different literatures by one author group, the data could only be used for one time. The items as the follows: the first author's name, publication year, region, discipline, theoretical scores, practical scores, matching criteria, and total number of PBL and LBL teaching method should be listed in Table 1.

2.3. Statistical Analyses

The theoretical and practical scores by PBL and LBL teaching method were compared in the current meta-analysis. The standardized mean difference (SMD) or the pooled odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) were used to explore the

effectiveness of PBL teaching method in the Chinese clinical training.

The heterogeneity among the studies was assessed by using the Chi-square-based Q-tests with the significance set at $P < 0.05$ level [7]. If the heterogeneity did not exist among the individual studies, fixed-effect model would be adopted (the Mantel-Haenszel method) [8]. Or else, the random-effect model would be used (DerSimonian and Laird method) [9]. The pooled SMD or OR was evaluated by Z test with the significance set at $P < 0.05$ level. The HWE was assessed by using the Fisher's exact test with the significance set at $P < 0.05$ level. The potential publication bias was assessed by using the funnel plot. The funnel plot symmetry was assessed by Egger's linear regression test on the natural logarithm scale of the OR with significance set at $P < 0.05$ level [10]. The statistical analyses were performed by using the Stata 12.0 software (Stata Corp, College Station, TX, USA).

3. Results

3.1. Studies and Populations

Twenty five manuscripts were found out through the retrieval process, among which thirteen manuscripts were eligible for the major inclusion criteria. Among the twelve excluded studies, five of them were reviews character, and seven of them could not provide the adequate data. The data used to compare the theoretical and practical scores was abstracted from the thirteen manuscripts including 458 students receiving PBL teaching method and 455 students receiving LBL teaching method (Table 1) [2,3,4,5,11-19]. Ten regions were included in the present meta-analysis as Liaoning, Shanghai, Beijing, Jiangsu, Jilin, Zhejiang, Henan, Fujian, Heilongjiang, and Yunnan.

Table 1. Characteristics of the investigated studies of the PBL and LBL teaching method in the clinical training in China (mean±SD)

Author	Year	Region	Discipline	PBL scores		LBL scores		Matching criteria	Sample size(PBL/LBL)
				Theoretical	Practical	Theoretical	Practical		
Shao LN [11]	2013	Liaoning	endodontics	77.53±7.87	79.87±4.21	71.53±7.83	73.47±4.26	Age, sex, class hour	15/15
Zhang Y[12]	2012	Shanghai	oral and maxillofacial surgery	86.74± 6.37	84.77± 5.20	89.12±7.74	83.97 ±8.10	Age, sex, class hour	43/44
Qian NS [13]	2015	Beijing	oncology	85.1±1.24	88.1±2.57	79.5±1.42	85.5±1.87	Age, sex, class hour	25/26
Li J [14]	2015	Jiangsu	Acupuncture	80.84±18.40	84.47±10.72	82.88±10.72	76.00±9.97	Age, sex, class hour	19/16
Wu Y [15]	2016	Zhejiang	neurology	78. 27±8. 25	86.77±4. 99	77. 05±8. 60	82. 97±5. 32	Age, sex, class hour	30/30
Duan XL [3]	2014	Jilin	orthopedics	46.27± 3. 11	42.39±2.19	39.76 ±2.16	36.21± 1. 83	Age, sex, class hour	40/40
Hu SQ [4]	2013	Beijing	Gastroenterology	85.73±6.31	77.52±8.20	78.66±8.86	70.69±8.85	Age, sex, class hour	58/56
Zhang H [16]	2015	Henan	Pediatrics	95.7±4.1	97.8±1.3	93.8±3.0	95.4±1.1	Age, sex, class hour	35/35
Zhang L [2]	2016	Jiangsu	orthopedics	89.17± 4.67	88. 00±5.41	82.75± 5.46	76.75± 6.33	Age, sex, class hour	56/56
Lin HB [17]	2014	Fujian	Bone Surgery	32± 3.7	50± 3.5	21± 2.5	41± 10.2	Age, sex, class hour	20/21
Wang HX [18]	2016	Beijing	Obstetrics and Gynecology	54.84±4.28	27.53±1.32	53.32±3.32	19.43±2.56	Age, sex, class hour	40/39
Dong B [5]	2015	Heilongjiang	Urology	81.49± 5.16	82. 41± 6. 05	80.31± 5.23	72.48± 7. 91	Age, sex, class hour	14/14
Wang Q [19]	2010	Yunnan	oral and maxillofacial surgery	81.38± 7.04	76.13± 5.34	78.25±6.01	66.06± 5.25	Age, sex, class hour	63/63

3.2. Pooled Analyses

The PBL teaching method had a positive effect on achieving higher theoretical (SMD=1.04, 95% CI: 0.51-1.56, P=0.0001) and practical scores (SMD=1.54, 95% CI:

1.03-2.06, P=5.54×10⁻⁹) than LBL teaching method in the Chinese clinical training. As there was a significant heterogeneity under the theoretical and practical scores models, the meta-regression has been conducted to explore the heterogeneity sources. The mean practical

scores in LBL group (Mpsl) was verified to be the main heterogeneity source under the theoretical and practical scores models ($P < 0.05$). In the subgroup analysis stratified by Mpsl, although the heterogeneity still existed in the two subgroups, the positive effect might be weaker in the $Mpsl > 73$ subgroup than that in the whole population or in the $Mpsl < 73$ subgroup (Theoretical scores: $Mpsl < 73$ subgroup: $SMD = 1.24$, 95% CI: 0.49-1.99, $P = 0.001$;

$Mpsl > 73$ subgroup: $SMD = 0.87$, 95% CI: 0.08-1.66, $P = 0.03$; Practical scores: $Mpsl < 73$ subgroup: $SMD = 2.01$, 95% CI: 1.11-2.91, $P = 1.19 \times 10^{-5}$; $Mpsl > 73$ subgroup: $SMD = 1.15$, 95% CI: 0.57-1.73, $P = 9.62 \times 10^{-5}$). It was suggested that the lower the mean practical scores in LBL group, the more positive effect of PBL teaching method on the clinical education in China. (Figure 1-Figure 2).

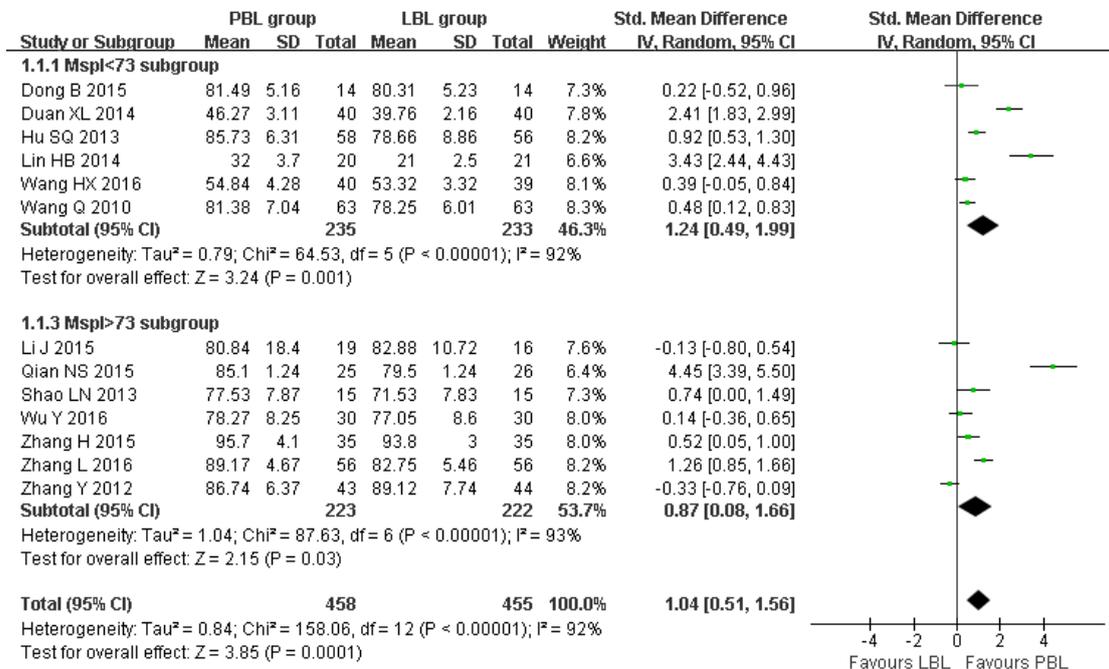


Figure 1. Forest plot of theoretical scores by PBL and LBL teaching method in the clinical training in China

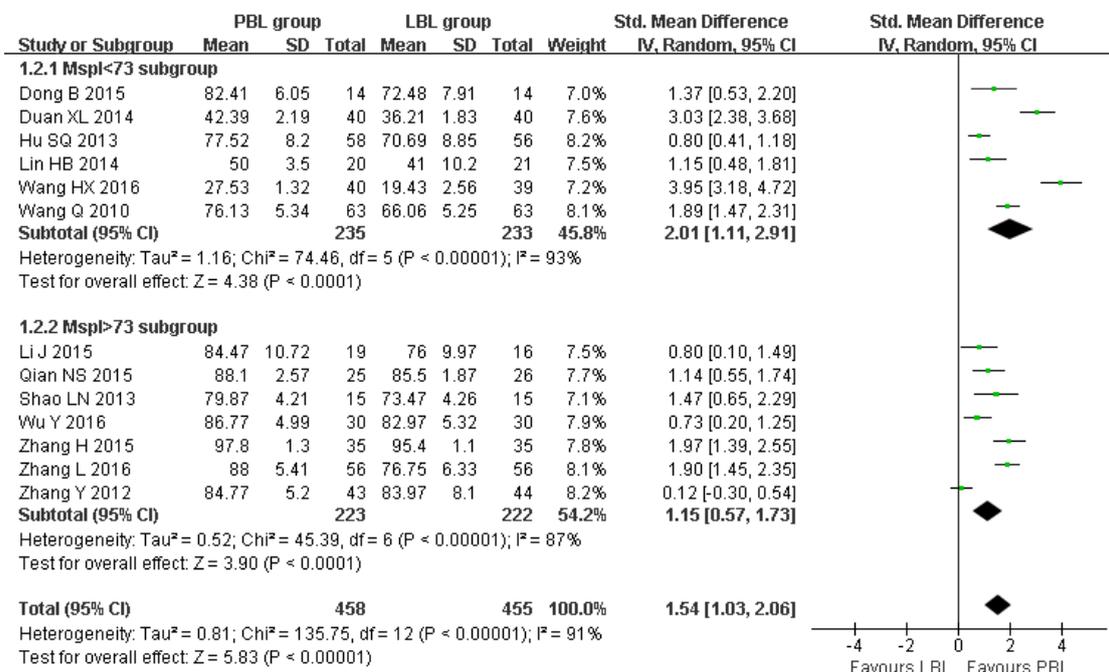


Figure 2. Forest plot of practical scores by PBL and LBL teaching method in the clinical training in China

3.3. Bias Diagnostics

The publication bias among the individual studies was assessed by Egger's test and funnel plot. Not any visual publication bias was detected in the funnel plot under the theoretical and practical scores models (Figure 3-Figure 4).

In addition, no significant difference was detected in the Egger's test yet, which implied that there was no publication bias in the current meta-analysis under the theoretical and practical scores models (Theoretical scores: $T = -1.16$, $P = 0.271$; Practical scores: $T = 1.47$, $P = 0.169$).

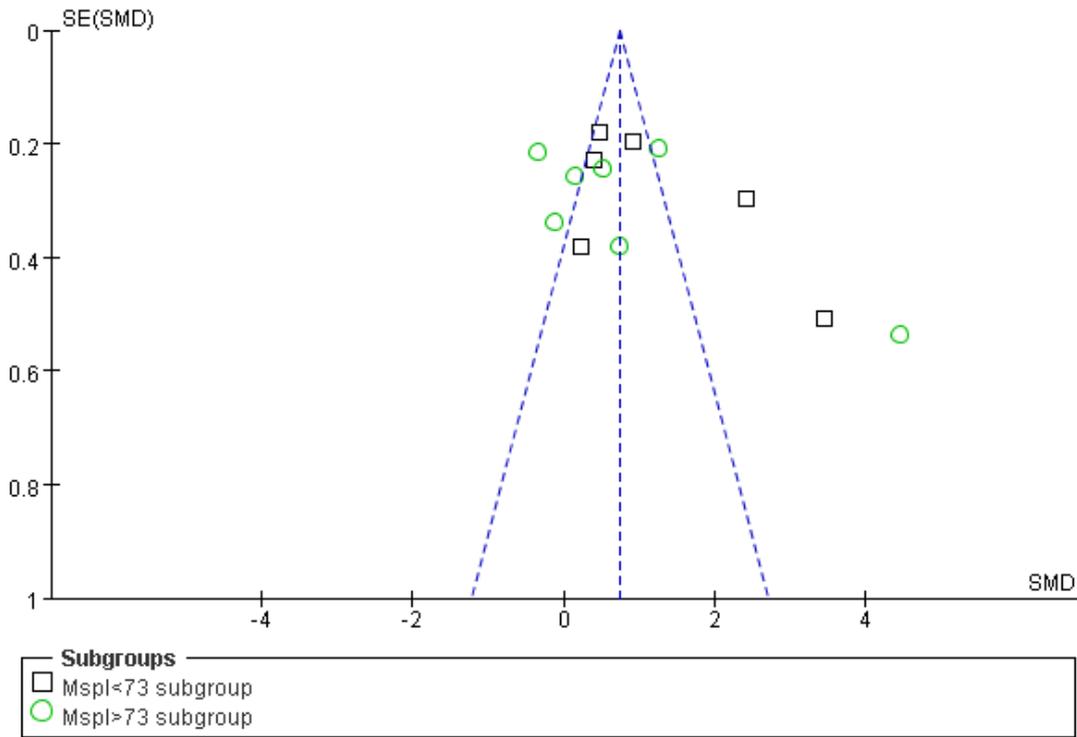


Figure 3. Funnel plot for studies of theoretical scores by PBL and LBL teaching method in the clinical training in China (The horizontal and vertical axis correspond to the OR and confidence limits. OR: odds ratio; SE: standard error.)

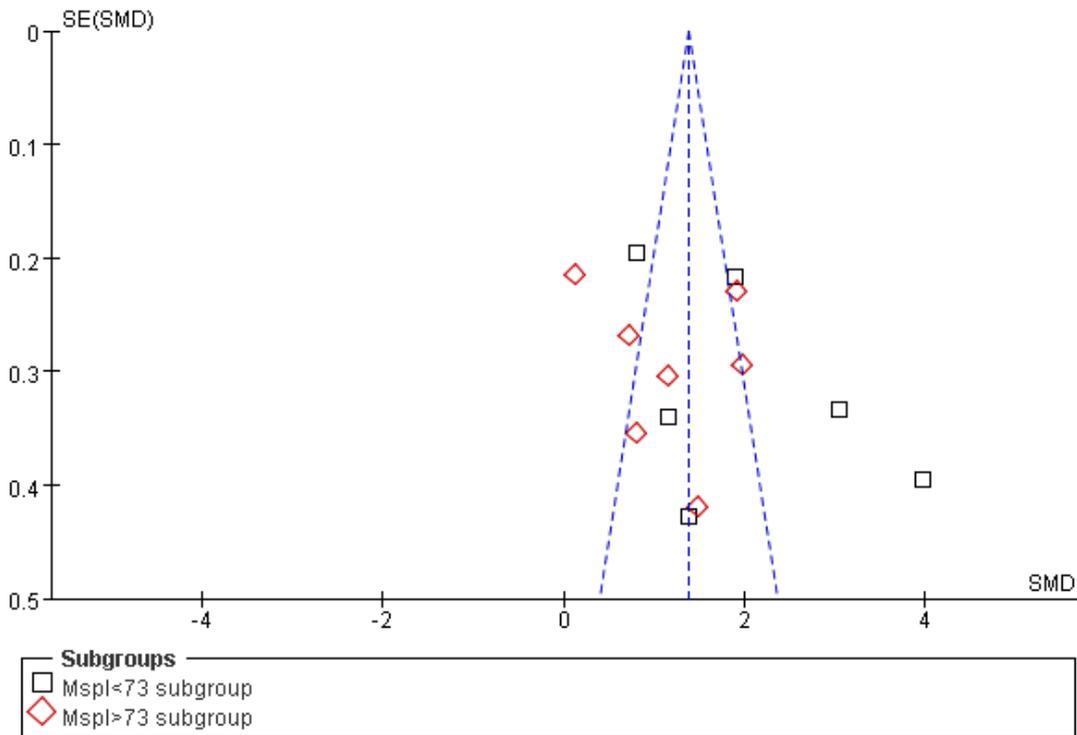


Figure 4. Funnel plot for studies of practical scores by PBL and LBL teaching method in the clinical training in China (The horizontal and vertical axis correspond to the OR and confidence limits. OR: odds ratio; SE: standard error.)

4. Discussion

In the present meta-analysis, it has shown that the PBL teaching method could achieve higher theoretical (SMD=1.04) and practical scores (SMD=1.54) than LBL teaching method in the Chinese clinical training. As the

significant heterogeneity existed under the theoretical and practical scores models, the Mspi was verified to be the main heterogeneity source by meta-regression. In the subgroup analysis stratified by Mspi, in the Mspi < 73 subgroup, the PBL teaching method could achieve higher theoretical (SMD=1.24) and practical scores (SMD=2.01) than that in the Mspi > 73 subgroup (theoretical: SMD=0.87; practical scores: SMD=1.15). It was indicated

that the lower the Mpsl, the better effect the PBL teaching method had on the clinical education in China.

It is emphasized that the PBL pedagogy is a student-oriented, problem-based, and case-guided characteristic teaching model which is executed in some developed countries at present. It was indicated that the PBL teaching efficiency was superior to that of the traditional teaching model and the PBL was worthy of popularization and application. The PBL pedagogy has the superiority as the follows. First, the PBL is in favor of stimulating the learning interests and initiative and promoting the self-study ability. Second, the PBL helps the students understand the new knowledge and consolidate the old knowledge. When the teachers design the issues, they blend various basic and clinical subject knowledges into the issues. Thus it could make the students understand the new knowledge and consolidate the prior knowledge simultaneously. Third, the PBL helps train the student comprehensive qualities and abilities [19].

The traditional LBL pedagogy makes the students get used to the passive acceptance of the knowledge taught by the teacher which goes against the comprehensive quality training. By contrast, the PBL pedagogy is a problem-based learning which makes the students study on one's own. So the students could improve the abilities of data collection, interpersonal communication, analyzing and solving the problems by previewing the materials, information retrieval, data induction and analysis, viewpoint extraction, and human communication. Moreover, the students could improve the logical thinking and specific language rein abilities by discussion and improve the language expression abilities by classroom elaboration and comments between each other [19]. As we know, Facebook and Twitter are well introduced into medical education in western colleges and universities. Recently, WeChat have been widely utilized as a new clinical teaching tool for PBL pedagogy in Chinese medical colleges and exert a positive influence [20].

In 2013, Huang et al performed a meta-analysis on the effectiveness of PBL in Chinese dental education. They found that the PBL had a positive effect on gaining higher theoretical (SMD=0.88) and practical scores (SMD=1.48). Their meta-analysis suggested that the PBL pedagogy was considered superior to the traditional LBL in the Chinese dental education [21]. Their results were similar to that from the current meta-analysis. In 2014, Fanet al surveyed the PBL usage at Chinese medical schools and they found that a large majority of schools used PBL. However, they reported that most schools used PBL for less than 50% of total clinical curricular hours. Their results suggested that schools were interested in increasing the PBL curricular hours but were perhaps constrained by resources [22]. Furthermore, the PBL still has some deficiencies. First, individual student has the negative participation emotion. They always depend on the teachers summarizing after class and never actively participate in discussion. Or they just grasp the superficial phenomenon and ignore the deep consideration of the problems. Second, the information collection is too simple. Some students do not collect the information carefully in order to complete the task quickly. Third, the PBL take too much time. Each teaching method has its own internal shortcomings and defects. In part of medical colleges of Canada, United States of America, Finland, and Australia, the simple PBL pedagogy has been

abandoned gradually at present. When the classic PBL pedagogy was implemented, more teaching content was also increased. In brief, the teaching method should be selected according to the student specific circumstance, teaching objectives and contents, and the data collection conditions [23].

There are still some limitations in the present meta-analysis. The present meta-analysis was still short of large-scale studies on the effectiveness of PBL teaching method in the Chinese clinical training. Besides, most of the studies quality was not high because they were not randomized controlled trials. When the students entered the university, they were divided into classes, so the investigators always allocate the students based on the classes rather than the individuals. As a survey in the educational field, it is impossible for the investigators to use the double blinding method during the whole course. Additionally, there was great heterogeneity in the theoretical and practical scores between the individual studies, although it has been corrected by using the random-effect model, it might still influence the conclusion to an extent.

In conclusion, the PBL was more effective in the Chinese clinical training than the traditional LBL teaching method. The application of PBL should be carried out on a larger scale in Chinese clinical education. The PBL effectiveness should be maximally optimized with all the above mentioned limitations.

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Declaration of Interest

The authors report no declarations of interest.

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