Application and evaluation of problem-based learning in undergraduate clinical education in 2014-2018

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Abstract

Objectives: In recent years, the rapid development of Problem-Based Learning (PBL) in Chinese medical colleges and universities is a self-directed learning mode comprising student-centered, issue-based and discussion-centered. This study evaluates the quality of PBL implementation and examines factors that affect the medical learning effect.

Methods: Based on the continuous application of PBL course among 234 of undergraduates majoring in clinical medicine from 2014 to 2018, we assessed the learning effect and curriculum implementation through examination and questionnaire.

Results: PBL preliminarily promotes the learning abilities of medical students in several aspects, including literature inquiry ability (83.76%), autonomous learning ability (74.79%), teamwork ability (60.26%), interpersonal communication ability (61.11%), language expression ability (72.22%) and critical thinking ability (53.85%). However, further analysis reveals that there are still many underlying issues to be solved, such as rapid decrease of learning interest and involvement, low learning efficiency in unit time, etc. We make a thorough discussion and put forward some recommendations.

Conclusions: This study indicates that PBL is an effective learning mode for undergraduate medical education, which would be beneficial by flexible adjustment of PBL curriculum practice, applying different cases in accordance with student's aptitude and enhancing the training of experienced clinical tutors.

Keywords: Problem-based learning; Curriculum; Autonomous learning; Clinical scenario; Medical education
Introduction

In recent years, Problem-Based Learning (PBL) mode has been used more and more widely in medical education in China. While it has achieved good results in the process of continuous improvement and innovation, it also faces new challenges and dilemmas. PBL is a set of learning methods that design learning situations, problem oriented and group centered. Different from the lecture-based learning (LBL), PBL mode inspires students' autonomous learning instead of traditional teacher's teaching. It guides students to grasp knowledge and improves the ability of solving problems and autonomous learning through group discussion (Alrahlah, 2016). The core of PBL lies in guiding the learning process with questions and exerting students' subjective initiative. In clinical medicine education, PBL guides students to study independently through group cooperation by case settings, and tutors help them to achieve teaching objectives and enhance students' abilities. As one of the most basic elements of PBL, the case must include two characteristics: one is that students may encounter the unstructured problems in the "real world" in the clinical field, and the other is that there is no fixed solution and process. In addition, self-evaluation and group evaluation after each case are also crucial (Yin et al., 2015).

Methods

1. Methodological framework

In the application of PBL, we designed the following curriculum. The students are divide into groups of eight to ten. The chairman who is responsible for controlling the class process and the pace of discussion, and the recorder who is responsible for recording the contents of the class are freely elected before each lesson begins. Each case is learned through three lessons in six hours, two hours/lesson/week. The PBL lessons in each case are performed as the following procedure. (1) In the first lesson, students introduce themselves, elect the chairmen and the recorders, and the tutor distributes the first two scripts of the case. The chairman guides the students to analyze and discuss information in the first two scripts. Meanwhile, the recorder is in charge of summarizing the issues and any valuable information that are mentioned. At the end of the first lesson, the students make self-evaluation and group evaluation of this script, and the tutor finally summarizes the comments. After the class, the students perform literature search and data collation according to the proposed issues, and solve the problem. (2) In the second lesson, the new chairman and the recorder are elected. The chairman guides the process, solves the problems left over from the last lesson, and the students share and exchange their knowledge. Then the tutor distributes the third script, and the students analyze and raise the questions. At the end of the second lesson, they make self-evaluation and group evaluation according to the representation. Furthermore, students solve issues of the third script through books and Internet after the class. (3) In the third lesson, the chairman and the recorder of the third lesson are elected. After the chairman leads the problem solving in the third script, the members take turns to sum up and evaluate their teammates. Finally, the tutor summarizes and gives the comments of total performance of every student. In the whole course, tutor plays the role of observation and indispensable guidance. The final grade of the course is composed of process evaluation (e.g. ordinary class performance) and semester assessment (e.g. final assessment).

2. Population and sample

From 2014 to 2018, the PBL course was performed among undergraduates majoring in clinical medicine. Three cases were studied in each semester. A total of 234 students participated in this study, including 119 males and 115 females, mainly from freshmen to juniors (Figure 1A). From the perspective of major distribution, these students were mainly 169 of eight-year clinical medicine (8Ymed) in combined bachelor's and master's degree program, 26
of five-year clinical medicine (5Ymed) in bachelor's degree program. 39 of four-year clinical related majors (4Ymed) in bachelor's degree program including nursing and rehabilitation medicine, laboratory medicine, etc. All students were informed the purpose of the study and agreed to participate in, all evaluations and questionnaires were administered anonymously.

3. Data collection and analysis

After the PBL course was completed, the learning effect was evaluated. Besides, the improvement of students' abilities, students' after-class learning time, students' expectation of tutor's background and so on were further investigated. The final examination and investigation were conducted at the end of the semester. All data were analyzed using SAS 9.1 software according to the classification of majors and grades. Chi-square test was used for counting data, and mean ± standard deviation was used for measuring data. T test was used for comparison between groups, P < 0.05 was significant difference.

Results/Analysis

1. Promote the learning abilities preliminarily

We examined students' performance in literature retrieval, autonomous learning, teamwork, interpersonal communication, language expression and critical thinking, respectively. The results showed that PBL preliminarily promoted the learning ability in different aspects. 83.76% (n=196) of the students thought that PBL model could improve their literature retrieval ability, 74.79% (n=175) of the students thought that autonomous learning ability had been improved, more than 60% (n=140) of the students thought that language expression ability and teamwork ability had been improved, 53.85% (n=126) of the students thought that their critical thinking had been exercised (Figure 1B). The result demonstrated that PBL had many advantages in promoting learning ability. In PBL mode, the students were at the center and the tutor played an inspiring and auxiliary role in the whole course. Compared with the traditional LBL mode, PBL enabled students to acquire knowledge by actively consulting books, browsing databases, sharing and communicating with teammates, rather than passively receiving teacher's explanations. In this process, the way of self-study stimulated students' interesting in learning. The students not only had a more thorough understanding of knowledge and a higher degree of mastery, but also learnt the strategy to solve problems (Phungsuk, Viriyavejakul and Ratanaolarn, 2017). In the meantime, several abilities including autonomous learning, literature retrieval, language expression and teamwork were cultivated, encouraged students to challenge authority and cultivated their critical thinking (Latif et al., 2018; Zhang et al., 2018). Therefore, PBL mode can fully inspire students' subjective initiative, facilitate students to master and understand knowledge, and enhance students' ability in all aspects.

However, by further analysis of different grades of students, we found that with the increase of participation in PBL courses, the degree of improvement in senior students generally showed a significant decreasing trend, especially in critical thinking and team work (Figure 1C). The learning ability of the freshmen was the most significant, and then decreased every year. This trend indicated that with the establishment of relevant knowledge framework, the current PBL mode was unable to meet the needs of medical students to further enhance their learning ability. Our in-depth analysis showed that the current PBL mode mainly had the following issues to be solved urgently.

Figure 1. PBL mode promoted the learning abilities. (A) The distribution of students participating in PBL course. (B) Improvement of learning abilities. (C) The different aspects of learning abilities in different grades of 8Ymed students. *, p<0.05
2. Shortage of tutors from clinicians

According to the results of the evaluation, we found that the PBL tutors were mainly from basic medicine related majors in medical colleges. However, for clinical students, as many as 77.78% (n=182) of students definitely expected clinicians to be tutors of PBL courses, and only 1.28% (n=3) of students chose tutors with non-clinical background (Figure 2). According to different majors, 84.62% (n=143) of 8Ymed students and 88.46% (n=23) of 5Ymed students were inclined to choose clinicians for PBL course guidance. The expectation ratio of 4Ymed students to the clinicians and medical technicians reached 56.41% (n=22). Further analysis of 8Ymed students showed that the proportion of choosing clinicians increased from 80.15% (n=135) in the grade one to 92.11% (n=156) in the grade third (Figure 2). These results indicated that among the current PBL tutors, students intensively demanded experienced clinicians to guide their learning, while the current tutors from clinicians were still seriously insufficient. This further showed that the PBL tutors should not only have a strong organizational leadership ability, but also need to have massive clinical professional knowledge and rich clinical experience.

Figure 2. PBL tutor's professional background. (*, p<0.05)
3. Learning interest and involvement decrease rapidly

The results showed that students’ interest and involvement in PBL course were significantly different. Only 22.65% (n=53) of the students could continue to actively participate in the course of learning, who still maintained a high level of learning interest after a number of PBL case. Up to 61.53% (n=144) of students lost interest in PBL course after 1~3 of PBL cases (Figure 3). This also led to nearly 24.36% (n=57) of the students choose the traditional LBL mode in the subsequent study, who believed that there was no need to continue PBL course.

We further analyzed that there were three main reasons. (1) Lack of simulation of clinical scenarios. The results showed that approximately 90% (n=211) of the students indicated that PBL course was mainly based on the knowledge that could be found in textbooks and databases, but lacked logical inference and diagnostic thinking related to clinical practice. There were obvious deficiencies in simulating the clinical situations. Routine learning of knowledge was far from meeting the needs of students who wanted to be closer to the real clinical scenarios, which made students feel disappointed and even gradually lose interest. (2) Lack of innovation in compilation of PBL case. Because the compilation was usually followed the same pattern, after undergoing one or two cases, students can reckon on the subsequent development at the beginning of the new case, thus losing interest in the follow-up courses. (3) Rigidity of curriculum practice. In current PBL course, the learning tasks in each case were presupposed and strictly fixed, but the time required for students to solve different cases and problems varied. Due to the lack of flexible adjustment of the time arranged by the course, students often had a lot of time left or insufficient after solving the issues in class. In addition, there were some rigid processes in the PBL curriculum, such as self-introduction at the beginning of each case, self-evaluation at the end of each lesson and group self-evaluation. It was tedious and unnecessary for students to introduce themselves in each new case, even students from the same administrative class, because they were already familiar with each other before they joined PBL course.

Figure 3. The time for significant decline of learning interest and involvement in PBL course. (*, p<0.05)
4. Low learning efficiency in unit time

According to the application of PBL course, we found that students used a large amount of time to discuss and share in each lesson. In this process, students tended to think too divergently, deviate from the content of the topic, or repeat the presentation and sharing of the same knowledge, which depressed the learning efficiency of the unit time. Additionally, in order to provide enough time for students to carry out after-class stage of learning, achieve documents retrieval and summary of knowledge points, the PBL lesson was designed once a week. But the results showed that 45.29% (n=234) of the students spent less than three hours a week on after-class learning (Figure 4). This indicated that there was a lot of spare time between the two lessons. The student's learning enthusiasm and thinking state possibly declined or even forgotten the last content in course, the learning efficiency naturally decreased. To solve this problem, however, it was not considered that simply increase the number of cases to improve the frequency of learning. Our results showed that 80.77% (n=234) of students believed that one to three PBL cases per semester was the most appropriate (Figure 4). This suggested that it was necessary to shorten the time in single lesson and the interval time in single case, so as to make the course more compact and improve the overall learning efficiency.

Figure 4. The learning time after-class per week and the expected number of PBL cases per semester.
Discussion

1. Flexible adjustment of PBL curriculum practice

PBL has a unique advantage in creating a relaxed and stress-free learning and discussion environment. Students can speak freely and fully express their views in class. After class, students can study independently through books and networks, and share with their teammates in the next class (Erdogan and Senemoglu, 2014). This cultivates student's ability of independent learning, literature inquiry, teamwork, language expression and other aspects. But PBL also produces issues such as too loose in discussion, topics are not concentrated enough, student's knowledge is not comprehensive and systematic. Although the class environment of traditional LBL is not easy to mobilize and students' subjective initiative has some limitations, the LBL mode indeed help students to grasp knowledge more systematically and comprehensively, and to understand more deeply about the knowledge points. So both of PBL and LBL have their own advantages. It will be beneficial if we combine to adjust and integrate these two modes. Tutor can adjust flexibly in the learning process, such as strengthening the guiding role of tutor, focusing on cultivating the clinical diagnostic thinking and so on.

2. Apply different cases in accordance with student's aptitude

Because of the differences in personality, ability and subjective initiative, every student's feedback on PBL learning effect is quite different (Chang, 2016). PBL is a student centered learning mode. Many students are not adapted to PBL at first. According to the differences in knowledge reserve and demand between students of different grades and majors, it is required to provide the specific and targeted PBL cases. Therefore, PBL cases can be divided into basic type and clinical type. The main goal of basic type is to let students experience and familiarize themselves with the learning process of PBL, adapt to the free discussion environment of PBL course. Meantime, master some basic knowledge, cultivate students' humanistic spirit of empathic thinking. The clinical type focuses on the integration and application of the basic medical knowledge, learning the clinical knowledge, training their diagnostic thinking and clinical deductive reasoning ability.

3. Enhance the training of experienced clinical tutors

PBL has a higher requirement on the quality of tutors. Because knowledge, behavior and personal ideas have a great impact on students, tutor must change the traditional teaching habits, fully understand the core elements of PBL learning mode, familiar with its teaching process (Williams and Paltridge, 2017). It is essential to recognize that tutor functions as the organizer, the participants and the guider of whole PBL course, which is also the key to successful application of PBL mode. Tutors' clinical knowledge reserve must be able to support them in judging whether students' learning direction is deviated and whether the conclusion of students' communication and discussion is correct (Mubuuke, Louw and Van Schalkwyk, 2017; Ibrahim and Al-Shahrani, 2018). So it is very important to train skilled and experienced tutors, especially focus on the clinical professional knowledge. Therefore, the tutor training should take into account two aspects, both of teaching ability and clinical skills.

Conclusion

This study indicates that PBL is an effective learning mode for undergraduate medical education, which would be beneficial by flexible adjustment of PBL curriculum practice, applying different cases in accordance with student's aptitude and enhancing the training of experienced clinical tutors.
Take Home Messages

1. Autonomous learning, literature retrieval, teamwork, interpersonal communication, language expression and critical thinking were preliminarily improved through PBL curriculum.
2. Enhance the training of experienced clinicians to solve the shortage of clinical tutors.
3. Flexible adjustment of PBL curriculum to solve the low learning efficiency in unit time.
4. Apply different cases in accordance with student's aptitude to solve the rapid decrease of learning interest and involvement.

Notes On Contributors

Jie Sun is an assistant professor of pharmacy at School of Public Health Nanjing Medical University, P.R.China. Dr. Sun's research mainly focuses on the application of problem-based learning and e-learning, designing the medical curriculum.

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Appendices

None.

Declarations

The author has declared that there are no conflicts of interest.

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Ethics Statement

This study was approved by institutional review board of Nanjing Medical University (No.11388).

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