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The Application of PBL Methodology in the Experimental Teaching of Ultrasonic Diagnostics

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Abstract—To evaluate the effect of problem-based learning (PBL) methodology in ultrasonic diagnostics experimental teaching. Sixty-one undergraduates majoring in medical imaging were randomly divided into control group and experimental group. Thirty-one students in the control group were taught by traditional teaching method, another 30 students in the experimental group were approved PBL methodology. After the courses, all students had exams to test their theoretical knowledge, operational skills and film reading abilities. Questionnaires were applied for self-assessment after class. T test was used to assess the statistical significance of the changes. The average score of theoretical in the experimental group was higher than control group, but there was no significant difference (P > 0.05). The results of operational skills and film reading abilities in the experimental group were significantly better than the control group with statistically differences (both P < 0.05). The questionnaires showed that students in the experimental group were more satisfied in terms of interest in ultrasonic learning, autonomous learning ability, operation ability and teaching situation than control group (all P < 0.05). PBL methodology can improve students' operational skills, fully arouse students' interest in ultrasound diagnostics, and has a positive teaching effect.

Keywords—Problem-based learning, ultrasonic diagnostics, experimental teaching

I. INTRODUCTION

Ultrasonic examination plays an important role in the diagnosis and prognosis of diseases. Ultrasonic diagnostics, which includes theory teaching and experimental teaching, is the compulsory course for students majoring in imaging and is an important part of imaging courses. It requires doctors not only can diagnose diseases, but also have skillful manipulation to ensure the quality of imaging, the comprehensive scope of examinations and the accuracy of diagnosis [1], so the experimental course of the ultrasonic diagnostics becomes a crucial progress to train students' operation skills and image analysis ability, also it is a consolidation for theoretical knowledge. However, for various reasons, students in the experimental class usually have few chances to practice, moreover, there were vast differences between ultrasonic images and CT or MR images, which lead more difficult for students to learn. As a result, most students are not very enthusiastic about ultrasound course and few students choose ultrasonic as their major during national post-graduate entrance examination. In recent years, Problem Based Learning (PBL) methodology has been widely implemented in medical class and ultrasonic teaching [2], and we also have achieved better effects in our previous study [3]. Therefore, in this study we attempted to apply PBL methodology to the experimental teaching of ultrasonic diagnostics, in order to improve the quality of teaching and stimulate students' interest in learning.

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II. MATERIALS AND METHODS

A. General information

Sixty-one undergraduates in grade 4, aged 21-23 years, 18 boys and 43 girls, were selected. They were randomly divided into control group (n=31) and experimental group (n=30).

B. Methods

1) Traditional teaching method

The students in the control group were taught by traditional method. First of all, the instructor reviewed the theoretical knowledge together with students, explained the normal ultrasonic image and examination methods. Then reserved a certain time to show the operations, and guided the students to operate the equipment by them.

2) PBL teaching method

The students in the experimental group were taught by PBL method. Thirty students in the experimental group were divided into six subgroups, and one leader for each subgroup. Students were required to learn how to use ultrasound to diagnose diseases by themselves in their spare time based on the questions of the experimental themes. To settle these questions, they should not only review the anatomy, pathophysiology, and other courses, but also learn ultrasonic knowledge automatically. It also was required to master the operation points of the ultrasonic equipment when looking up information by network or other video information.

In the experimental class, first, the students shared their knowledge of different diseases group by group. At the same time, the instructor recorded the main points of the students' explanation, and finally summarized the key information. After discussion, the instructor demonstrated the operation skills of the ultrasonic machine. Then the students operated the equipment in groups according to the video learning and the instructor's explanation. One examinee was selected in each

group, the rest of the students in turn as the examiner, to simulate the process of clinical examination. The focus was to observe the students' manipulation and images changes. The examinee should reflect the differences between different students' manipulation, so that the examiner could more deeply understand the changes of manipulation and intensity during the examination.

C. Evaluation

(1) At the end of the experimental class, theoretical tests and operation assessment including computer operation and image reading were conducted.

(2) Questionnaires were sent out after the experimental class, which included the interest in ultrasound learning, autonomous learning ability, hands-on operation ability, teachers' satisfaction with teaching and so on.

D. Statistical analysis

Independent-Sample T test was used to analysis the results of control group and experimental group. $P < 0.05$ was considered statistical significant. Statistical analysis was performed in SPSS version 22.0.

III. Results

A. Comparison of theoretical scores and practical results between two groups

All 61 students participated in the examination after class. The average theoretical score of the control group was 83.19±4.14, and the experimental group score was 84.83±4.03. The theoretical score of the experimental group was higher than the control group, while there was no statistical difference between these two groups ($P > 0.05$). In terms of operational skills and film reading abilities, students in experimental group scored higher than control group: the scores were 35.77±3.17 vs 33.13±2.14, P=0.000; 36.97±3.99 vs 34.06±3.07, P=0.002, respectively, which showed significant differences between two groups. (Table 1)

TABLE I. Comparison of theoretical and practical results between two groups

Group	Number	Theoretical scores	Skills assessment	
			Operational skill	Film reading
Control group	31	83.19±4.14	33.13±2.14	34.06±3.07
Experimental group	30	84.83±4.03	35.77±3.17	36.97±3.99
T		1.567	3.796	3.176
P		0.122	0.000	0.002

B. Questionnaire results between two groups.

A total of 61 questionnaires were recovered, with a recovery rate of 100%. According to the questionnaire result, it showed that the students in the experimental group were more interested in learning ultrasonic diagnostics and their abilities to learn automatically had been more improved than those in the control group. They would like to spend more time in library or searching literature. The students in the experimental group felt more confidence in the operational examination. They were satisfied with PBL method. (Fig. 1).

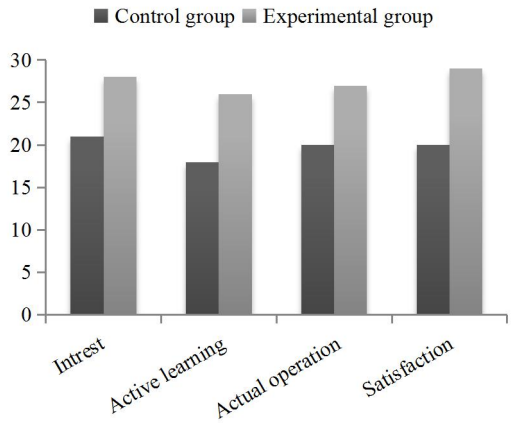

Fig. 1. Questionnaire results of two groups.

IV. Discussion

Ultrasonography is a practical subject, and the operator is directly related to the accuracy of its diagnosis [4]. Ultrasonic diagnostics experimental course is an important supplement to theory learning. The students' operation skills and diagnostic ability are supposed to improve by the experimental learning to strengthen their comprehensive qualities [5].

PBL is a kind of teaching method, student-centered, problem-oriented, proceeding from clinical problems and teaching around a practical case or medical problem. It aims to stimulate students' interest in learning, improve students' autonomous learning ability, so as to grasp the knowledge more comprehensively and profoundly [6]. Studies have noted that PBL methodology has positive effect in medical learning, especially for long time memory and operation skills. In this study, we also have found PBL method has several advantages in the experimental learning.

First of all, PBL method can cultivate students' team consciousness. Students were divided into different groups by PBL method, and everyone in the group should work together to consult literature, collect data and organize data so as to resolve the problem. This learning mode helps students to establish team consciousness and cooperate with each other, which lay a good foundation for future clinical work.

Secondly, PBL method can improve students' learning efficiency and learning interest. PBL method requires students to study with problems and consult literature. This purposeful learning method avoids the blindness of learning and makes more efficient. They have learned more knowledge about the problem than control group at the same time. In this study, every student in the experimental group is required to find the answers to all the questions, understand various knowledge of the problem profoundly, so as to learn the characteristics of each organ's ultrasonic images more easily. The students' theoretical average score in the experimental group was higher compared with the control group, but there was no statistical difference. That was similar to previous study, which indicated that PBL method might promote students' learning, but in terms of short time learning or knowledge acquisition, there was no obviously effect [7].

Being able to operate equipment during school is a different experience for students, which can better motivate students' enthusiasm for learning. As the ultrasonography not only has cross section, but also vertical section, oblique section and coronal section, this requires students to have the concept of space stereo. The video self-study results can be feedback in the experimental class to achieve a deeper understanding of the actual operation. Through this way, students' interest in learning ultrasonography will be motivated and are more looking forward to the next experimental class. The questionnaire results showed that students in the experimental group were more interested in learning ultrasound than those in the control group. They will learn ultrasound knowledge more actively after class, and their classroom performance is more prominent.

Thirdly, PBL method can improve the active learning and cultivate scientific thinking, which is necessary for a doctor. PBL method requires students to find the answer through different aspects by different ways. In this procedure, they will learn how to self-study. This paper showed the self-study ability of the students in experimental group was significantly improved compared with the control group by questionnaires. The students in experimental group were more willing to take the initiative to find problems and find answers in the future. To find more answers of the problem, it requires students to learn to consult literature, use network resources, summarize the contents, and draw their own views and conclusions. This process exercises their scientific thinking and ability, and lays a solid foundation for future work.

Fourthly, PBL method can cultivate students' empathy and communication ability between doctors and patients. In the experimental group, everyone acted as both the examiner and the examinee. They discussed with each other about the influence of the movement of the probe and changes of the ultrasonic image during the examination, so as to get a more intuitive understanding of the matters needing attention in the practice. Meanwhile, role experience also enabled students to understand the importance of doctor-patient communication in advance.

V. CONCLUSION

In conclusion, PBL method has achieved a good result in the ultrasonic experimental course, and students had a high acceptance. In the future, we will increase the application of PBL method in experimental courses to improve students' interest in learning and enhance their practical ability to train more applied ultrasonic talents.

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