A teaching reform for integrating oral theory with clinical practice for dental students

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Background. The education transition from medical theoretical courses to clinical practice is an important, but difficult process for dental students. There is an urgent need to explore an effective teaching method to improve the ability of dental students to integrate oral theory with clinical practice. Methods. First, problem-based learning training, based on real clinical cases for dental students, was conducted. Then, the students were assigned to the roles of dentists and patients to rehearse and perform simulated clinical scenarios. Finally, questionnaires, clinical patient care scores, and performance assessments were utilized to evaluate the effectiveness of this training as compared with that of traditional teaching. Results. The abilities of the students after the teaching reform in terms of treating and communicating with patients increased markedly. Among the 30 enrolled students, 29 liked the method and found that it was time-efficient, and believed that it could help to enhance their problem-solving confidence and interest in prosthodontics. They also believed that this teaching method could help them with gaining a good understanding of the related theoretical knowledge, and generally thought that the reformed teaching method was more valuable than the traditional approach and would like to introduce it to others. Conclusions. After the teaching reform, the students not only had better theoretical achievements, but also demonstrated greater accuracy in diagnosing the conditions of patients and formulating treatment plans. It was much easier for them to obtain recognition from the patients, which indicates that it should be an effective teaching method for dental students.

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Abstract

Background. The education transition from medical theoretical knowledge to clinical practice is an important, but difficult process for dental students. There is an urgent need to explore an effective teaching method to improve the ability of dental students to integrate dental theory with clinical practice.

Methods First, problem-based learning training, based on real clinical cases for dental students, was conducted. Then, the students were assigned to the roles of dentists and patients to rehearse and perform simulated clinical scenarios. Finally, questionnaires, clinical patient care scores, and performance assessments were utilized to evaluate the effectiveness of this training as compared with that of traditional teaching.

Results The abilities of the students after the teaching reform in terms of treating and communicating with patients increased markedly. Among the 30 enrolled students, 29 liked the method and found that it was time-efficient, and believed that it could help to enhance their problem-solving confidence and interest in prosthodontics. They also believed that this teaching method could help them with gaining a good understanding of the related theoretical knowledge, and generally thought that the reformed teaching method was more valuable than the traditional approach and would like to introduce it to others.

Conclusions After the teaching reform, the students not only had better theoretical achievements, but also demonstrated greater accuracy in diagnosing the conditions of patients and formulating treatment plans. It was much easier for them to obtain recognition from the patients, which indicates that it should be an effective teaching method for dental students.

Introduction

The education transition from medical theoretical knowledge to clinical practice is an important, but difficult process for dental students. They normally conduct clinical practice in their last year of study, even some of them do not enter clinical practice (*D Xu et al, 2010*). However, during the traditional clinical practice, students do not have the right to perform the actual operation on patients, without enough time to communicate with patients in the clinic. They only

observe how teachers operate and communicate with patients, or only participate in a part of treatments on the patients. Inadequate teaching and incompatibility with clinical practice teaching directly lead to a major challenge faced by dental students. This challenge has been recognized as a problem of merging theoretical knowledge and clinical practice. Dental students do not know how to respond when directly faced with patients. They cannot apply the theoretical knowledge to the clinical diagnosis and treatment very well, which easily leads to medical disputes, especially in a strained doctor–patient relationship environment. Therefore, there is an urgent need to devise an effective teaching method that can improve the ability of dental undergraduate students to integrate dental theory with clinical practice.

Problem-based learning (PBL) training may provide a solution to this problem, which makes it possible to link learning with wider tasks or issues, and makes the learner engage with the problem. It is designed to use a high-authenticity task, emphasizing the study of learning in complex and meaningful problem scenarios. Learners can solve problems through self-exploration and cooperation, and learn the scientific knowledge based on the problem. Finally, students develop the skills to solve the problem and self-learning abilities. PBL training has been applied in medical education for more than 40 years (*Edward& & Thompson, 2013*). In the early period, the popularity of PBL training in the United States and Canada ensured its global spread as a teaching method. Some investigations have shown that medical students who underwent PBL training had better results in the medical licensing examination and clinical practice, and could had a better understanding of clinical problems and capacity for self-learning than students who underwent traditional teaching (*Blake, Hosokawa & Riley, 2000; Hoffman et al., 2006; Okubo et al., 2012; Khan et al., 2007*). Although PBL training has been widely used, the research of Kinkade et al showed that its application in medical colleges in the United States has declined (*Kinkade et al., 2005*), which was mainly because teachers realized that the preparation for PBL training was more time consuming, and that more teachers were required for the PBL module than for the traditional teaching method. In other words, it is more expensive to use a PBL training method than a traditional method. Therefore, the feasibility of spending so much human resources to conduct PBL training has been questioned (*Distlehorst et al., 2005; Colliver, 2000; Farnsworth, 1994; Kirschner, Sweller & Clark, 2006*). In China, with the deepening of education reform, PBL training has gradually been launched in medical education. Some researchers have investigated the use of PBL training in medical colleges in China, and found that PBL training had been commonly applied in the 43 medical colleges, and its utilization rate in the pre-clinical curriculum was about 50% (*Fan, Kosik & Tsai, 2014*). However, there have been very few reports showing satisfactory effectiveness of PBL training in dental undergraduate education.

Above all, a teaching reform of dental education that can better combine theoretical knowledge with clinical practice is needed (*Du et al,2010*). Traditional dental education has always used lecturing as the main teaching method, with the emphasis on enabling students to acquire relevant basic theoretical knowledge. Although this teaching method can help students to grasp knowledge points and holistic theory, it cannot attract their initiative. Therefore, the students lack the ability to apply their knowledge practically and the capacity for self-learning, and do not know how to apply clinical reasoning (*Wang, J. et al, 2010*). It is therefore very difficult for the students to link clinical practice with theoretical knowledge, or to apply knowledge they have never learnt in a lecture to solve clinical problems when they are faced with real patients. Although many education modules have been proposed for dental students, the critical

transition from theoretical teaching to clinical practice training remains unresolved (*Prince, 2000*). Since specialized teachers in medical colleges also commonly concurrently work as consultants in clinics, their dedicated teaching time is very limited. It is impractical to abolish the existing teaching method completely and replace it with the PBL teaching method overall. It is more appropriate to find a compromise between these two teaching methods, which should be more practical and better fulfil the professional training requirements of dental students (*S Baozhi et al, 2003*). Furthermore, from the feedbacks of students, we found that dental students who had been taught using traditional methods lacked not only sufficient capability in clinical practice, but also a satisfactory ability in communicating well with patients in clinics. We also found that the students were not able to pay enough attention to some necessary details, such as their appearance, attitude, tone and rate of speech, way of expression, etc., when communicating with the patients (*Du et al,2013*). Moreover, they did not show enough considerations to their patients before and during treatments. All these factors may not only cause medical disputes and mistrusts of patients in dentists, but may also have negative effects on the formulation of an accurate diagnosis and treatment plan.

Given the above, we designed a clinical simulation PBL training method to improve the ability of dental undergraduate students to integrate dental theory with clinical practice, and to enhance their professional skills, and compared its efficacy with that of the traditional teaching method.

Materials & Methods

Ethics Statement

A standard written informed consent procedure was included in the protocol, and was reviewed and approved by the Ethics Committee of China Medical University. All the participants were over the age of 18 years, and gave their written consent after the nature of study had been fully explained. The research was approved by the Ethics Committee of China Medical University, and conducted in full accordance with the World Medical Association Declaration of Helsinki.

Teaching objects and grouping

First, PBL training was conducted based on real clinical cases. To investigate whether the clinical-simulation PBL training method is applicable to dental undergraduate teaching, we divided 60 students into two group, 30 of whom underwent PBL training while another 30 received traditional teaching, as the control group. Questionnaires, clinical patient care scores, and performance assessments were utilized to evaluate the effectiveness of PBL training as compared with that of traditional teaching.

30 fifth-grade undergraduates from the school of Stomatology, China medical University participate in PBL training in 2017; these included 11 males and 19 females. Another 30 undergraduate students from the same grade who underwent normal class teaching without PBL training were set as the control group; these also included 11 males and 19 females. The 30 students in each group were further divided into five subgroups, with six in each subgroup. Each subgroup comprised members with different cognitive characteristics, aptitude, and personalities. There were certain differences. Among group members, but the overall study ability level of each subgroup was consistent.

Selection of four clinical cases for PBL training

The four selected clinical cases covered the basic elements of prosthodontics, which included dental defect repair, fixed partial denture repair, removable partial denture repair, and complete denture repair. Prostheses were applied as

111 the main treatments for all cases. However, before final installation of the prostheses, pre-treatments, such as dental
112 treatment of oral medicine, periodontal treatment, oral extraction surgery, etc., had been performed.
113 **Design of the training protocol**
114 Firstly, the students were given enough time for systematic discussion and analysis of the differential diagnosis, pre-
115 treatment plans, and restoration treatment plans of the four cases in their allocated groups. Then, they were asked to
116 devise a reasonable and comprehensive treatment plan. Finally, the students undergoing PBL training took turns to
117 play the roles of doctors and patients, conducting a simulated clinical diagnosis and treatment, while the remaining
118 students in the same group pointed out errors and proposed suggestions. All the students repeated the practice until
119 they received satisfactory evaluations from teachers and student judges.
120 Teachers proposed the PBL problems related to the four clinical cases 1 week in advance, and then announced the
121 four cases with the PBL problems to the students. Each group of students worked as a team to search the relevant
122 literature, and then submitted a summary report. Each team member was allocated an approximately equal amount of
123 workload according to his own characteristics after the internal group discussion. Once any team had teamwork
124 questions, the teacher would provide necessary guidance.
125 After each student had worked independently, all team members were asked to exchange their information, to discuss
126 the problem-solving process, and then to draw conclusions. Teachers encouraged their discussions, ensured that each
127 group could stick closely to the PBL theme, and re-examined the previous errors. Then, the group members continued
128 to optimize their written reports after checking with new relevant literature on the problems posed by the teachers.
129 The teachers instructed the students to summarize their experiences and compensate for their deficiencies throughout
130 the training process. They also evaluated the students' independent learning and collaborative abilities.
131 After listening to the presentations of all the groups, the teachers gave comments on the answers to the PBL questions,
132 and then provided corrective suggestions, if necessary. Furthermore, professional treatment advice was given to each
133 group based on their treatment plan.
134 **Evaluations**
135 Questionnaires, clinical patient care scores, and performance assessments were utilized to evaluate the PBL training's
136 effectiveness as compared with that of the traditional teaching approach. First, the students were surveyed after the
137 training, including their responses to the questions about the change in their general abilities or skills, the change in
138 their special abilities in treating the diseases or communicating with patients, the cognition of the teaching method,
139 etc.
140 Secondly, teachers selected five real patients in the clinic, and two groups (training group and control group) of
141 students independently admitted them. The patients included the ones who had the need for dental defects repair, fixed
142 partial denture repair, removable partial denture repair, and complete denture repair. The teachers finalized the clinical
143 case score sheet (total 100 points, table 1), which included the evaluations on the students' abilities in communicating
144 with patients, their auxiliary examinations before operation and differential diagnosis, the design and description of
145 their treatment plans, etc. The teachers marked each student's performances with scores for all the items in the sheet.
146 Then, we compared the scores of the PBL training group with those of the control group.

Finally, paper examination of prosthodontics was used to investigate learning outcomes of the two groups of students. The types of examination question were multiple choice, blank filling, short answers, and case analysis questions. Full marks for the examination was 100 points, while 60 points or less was considered as failure, between 60 and 90 points was considered a pass, and 90 or more points was considered excellent.

Results

After the end of the clinical simulation PBL training curriculum, the students were surveyed to evaluate the effect of the training. Figures 1 to 5 showed various aspects of the questionnaires, such as student responses to the questions about the change of their general abilities or skills after the PBL training, the change of their special abilities in treating the diseases or communicating with patients after the PBL training, the cognition of the teaching method, etc. The results showed that general abilities or skills of the students after the PBL training were markedly increased (Figure 1), such as their ability in independently searching literatures, comprehensive and logical analysis skills, teamwork ability, curiosity and exploratory desire of professional knowledge. Moreover, their special abilities in treating diseases or communicating with patients after the PBL training, including grasping indications for repair, correctly diagnosing the diseases, developing the treatment plans, quickly and accurately grasping the patient's condition, communicating with and understanding patients, were notably increased (Figure 2). Therefore, this teaching method was highly regarded by the students (Figure 3). Among the 30 students, 29 liked this teaching method. Twenty-eight students considered that this method was an efficient use of time. Twenty-six believed that this teaching method could help to enhance their problem-solving confidence. Twenty-seven students believed that this teaching method could increase their interest in prosthodontics, while 25 believed that this teaching method could help them to gain a better theoretical knowledge of prosthodontics. Twenty-eight students were keen to introduce this teaching method to others. Twenty-nine students believed that the value of this teaching method was greater than that of the traditional teaching approach (Figure 4). The students generally believed that PBL teaching can promote their critical thinking ability more than traditional teaching methods, and that this teaching method is very helpful for improving their capacity for self-learning. Furthermore, they considered that PBL training could facilitate comprehensive utilization of various theoretical facts into oral professional and clinical practice, and that clinical scenario simulation during the PBL training was especially helpful for the improvement of their linguistic skills and logical thinking and clinical practice ability.

The score sheets for clinical practice (Table 1) were designed to evaluate the students' clinical performance, including the requirements for the students' appearance, their attitude to the patients, their ability to communicate with patients, diagnose diseases, make a differential diagnosis, perform auxiliary examinations and operational examinations, devise early restoration treatment plan before making the prosthesis, patients' satisfaction, and so on. Table 2 shows that students who underwent clinical-simulation PBL training received an average score of 88.89, which was significantly higher than the average score of 67.27 received by the students who had not undergone the training (control group). This suggested that the clinical-simulation PBL training method was very helpful for students in clinical management of patients. More particularly, the sub-scores of items 3 and 10 were respectively 14.17 and 9.53, showing significant improvement as compared with the students in the control group (9.27 and 6.8). These results suggested that students' ability to communicate with patients had been improved. Students took turns to play the role of doctors and patients,

which reminded students to pay attention to details when facing patients, and established students' self-confidence, improving their skills, and thus ultimately gaining recognition from patients.

Figure 5 showed the prosthodontics examination scores of the clinical-simulation PBL training group and the control group. The average score of the training group was 82.80 points and the pass rate and the excellent rate were respectively 90% and 40%. The average score of the control group was 74.33 points and the pass rate and the excellent rate were respectively 70% and 23.33%. These differences were statistically significant ($P < 0.05$). These results indicate that PBL training can deepen students' understanding of the related theoretical knowledge, which leads to improved performance.

Discussion

Learning of clinical reasoning is a complex task, which includes the application of professional knowledge and the accumulation of experience from actual clinical cases. Due to the limited time for clinical practice, dental students only have limited contact with patients, with limitations in type and quantity, and clinical teachers do not allow undergraduate students to treat patients independently, for the patients' safety. Traditional teaching methods only focus on theoretical knowledge and lack training in clinical reasoning, and is thus unable to link theoretical knowledge with clinical cases. Therefore, after the students graduate, their learnt theory cannot be adequately applied in clinical practice. Moreover, they do not have enough self-confidence when faced with patients and lack the necessary abilities for interacting with patients effectively. PBL training can provide an entrance to this complex task for medical students (*Eva, 2005; Ark, Brooks & Eva, 2006; Rencic, 2011; Miflin, Campbell & Price, 2000; Wood, 2003*). PBL emphasizes that studies should be designed based on real life scenarios with complex situations and meaningful problems, to solve problems through cooperation of the students, and to help them learn the implicit scientific knowledge behind questions and form problem-solving skills and independent learning ability (*Srinivas & Susarla, 2004; Thammasitboon, 2007*). This method has been considered to stimulate self-directed learning, and to improve the capacity of lifelong learning and the level of multidisciplinary integration (*Distlehorst, 2005*). The PBL training method mainly involves discussions in small groups, which focus on the patients' medical history, physical examination, and laboratory data, as well as ultimate diagnosis and treatment plans.

With rapid development of dental medical technology, dentists must have the ability to learn new knowledge by themselves. Due to the special relationship between doctors and patients, the dentists should also have a good communication ability, to avoid misunderstandings. Therefore, a single traditional teaching approach for dental education is no longer applicable for dental students. It is necessary to improve the existing teaching methods and add innovative methods.

In this study, we have proposed simulated clinical PBL training on the basis of traditional teaching methods. Firstly, several typical clinical cases were chosen and compiled into the templates. Students were requested to collect the necessary information through literature review and then they discussed this within small groups to solve clinical problems independently, including formulating rational treatment plans and determining the most suitable treatment for patients. During this PBL training, the students were instructed how to apply the basic dental theoretical knowledge to clinical cases. The training provided students with an opportunity for simulation practice, to maximize simulated

clinical practice, stimulating the students' self-learning capacity and problem-solving skills when faced with real patients in the clinic.

Besides the ability to apply the basic dental theoretical knowledge to clinical cases, a dentist should have a satisfactory ability in communicating with patients, which enables them to obtain much relevant information about medical history and the current disease situation of the patients, and they should be able to formulate accurate diagnosis and treatment plans. Therefore, in the second part of the training, some of the students in the PBL group took turns to play the role of doctors and patients, conducting simulated clinical diagnosis and treatment, while the other students in the same group acted as judges to point out errors. All students repeated the practice until they received satisfactory evaluations from the teachers and their peers.

Both the general abilities or skills and special abilities in treating the diseases or communicating with the students' patients after the simulated-clinical PBL training were notably increased. After the training, the students had greater accuracy in diagnosing the patients' conditions and formulating treatment plans, and it was much easier for them to obtain the recognition of the patients. Furthermore, this teaching method was highly regarded by the students. These results indicated that the clinical-simulation PBL is likely to be an effective teaching method for dental undergraduate students.

Through this study, we found that many factors might determine the effectiveness of the clinical-simulation PBL training for dental undergraduate students: (i) appropriate clinical case selection, (ii) reasonable proposed problems, (ii) abundant rehearsal and role-play of dentists and patients, and (iv) sufficient preparation, discussion, and practice time. When choosing cases, teachers should fully consider the common occurrences in local clinics. For example, patients in prosthodontics clinics often need consultation of doctors from other oral departments, such as oral medicine, oral periodontal, oral surgery, etc. Therefore, the related contents from the whole oral major should be considered overall. Secondly, the difficulty is the implementation of the core part of PBL training implementation. The problems proposed directly affect the effectiveness of students' learning. The problems should be designed to attract the student's interests in understanding the cases. When discussions are restricted to certain issues, teachers should remind students to extend their range of consideration, and ultimately help students to find satisfactory answers and develop rational prosthetic treatment plans (*Barrows & Tamblyn, 2003; Hung, 2011; Li et al., 2015*). Thirdly, abundant rehearsal and role-play of dentists and patients significantly enhance the effectiveness of the clinical-simulation PBL training for dental undergraduate students. Cultivation of the students' communication and understanding has always been emphasized in modern higher education. For dental students, abundant rehearsal and role-play may help them to understand patients comprehensively and deeply, which is crucial for them to achieve a satisfactory diagnosis and make treatment plans. Fourthly, during training, sufficient time should be given to both teachers and students to ensure that teachers have enough time to instruct students properly, and that students have ample time to access relevant information, and to have full discussion and repeated practice to obtain good results.

Although satisfactory results have been obtained in this study, we noticed that there were still some challenges to conducting the clinical-simulation PBL training in dental schools. For example, there is only limited funding for dental education and educational research. Most of the teachers who are normally dentists do not have enough specific time allocated for the clinical-simulation PBL training. Many students lack adaptability to this training method. However,

we believe that along with its increasing recognition by dentists and students, and its continued optimization, clinical-simulation PBL training may become more widely applied in dental education.

Conclusion

In this study, clinical-simulation PBL training was designed to integrate dental theory with clinical practice for dental students. Firstly, PBL training was conducted based on real clinical cases. Students also had the opportunity to repeatedly participate in role-play as dentists and patients to simulate clinical scenarios. Both the general abilities or skills and special abilities in terms of treating diseases or communicating with patients increased after clinical-simulation PBL training. This training led to greater accuracy in diagnosing the patients' condition and formulating treatment plans, and obtain more recognition from their patients. Furthermore, this teaching method was highly regarded by the students. Thus, clinical-simulation PBL is likely to be an effective teaching method for dental undergraduate students

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Figure 1

Student responses to the questions about the change in their general abilities or skills after the clinical-simulation PBL training

The figure shows that student responses to the questions about the change in their general abilities or skills after the clinical-simulation PBL training

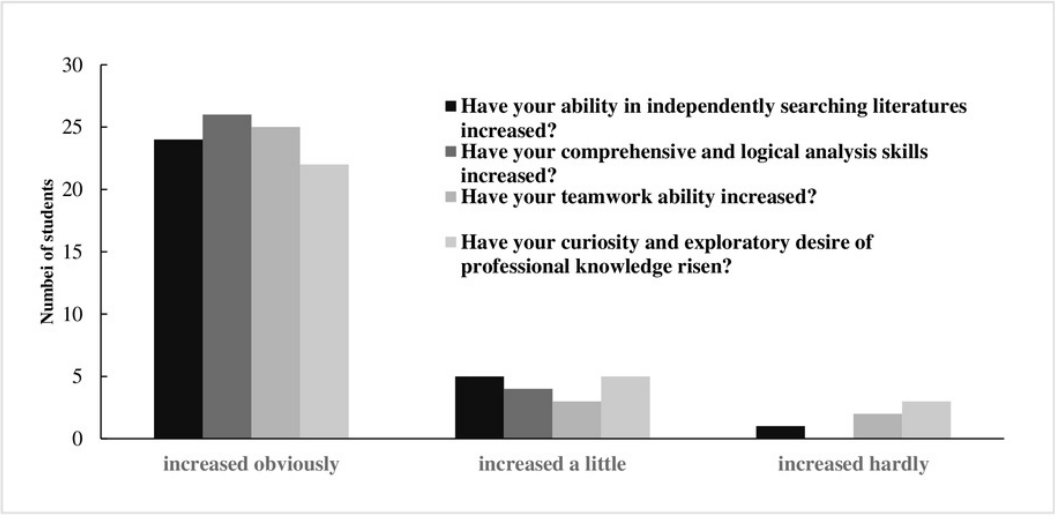
30
25
20
15
10
5
0
Numbei of students
Have your ability in independently searching literatures increased?
Have your comprehensive and logical analysis skills increased?
Have your teamwork ability increased?
Have your curiosity and exploratory desire of professional knowledge risen?
increased obviously
increased a little
increased hardly

Figure 2

Student responses to the questions about the change in their special abilities in treating dental diseases or communicating with patients after the clinical-simulation PBL training

The figure shows that student responses to the questions about the change in their special abilities in treating dental diseases or communicating with patients after the clinical-simulation PBL training

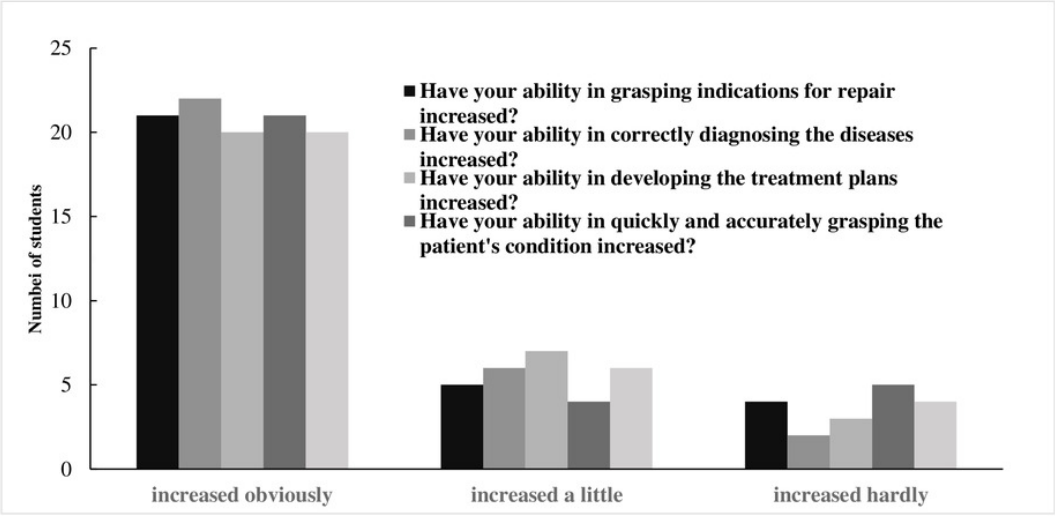
25
20
15
10
5
0
Numbei of students
Have your ability in grasping indications for repair increased?
Have your ability in correctly diagnosing the diseases increased?
Have your ability in developing the treatment plans increased?
Have your ability in quickly and accurately grasping the patient's condition increased?
increased obviously
increased a little
increased hardly

Figure 3

Student responses to the questions about their cognition of the teaching method

The figure3 shows that student responses to the questions about their cognition of the teaching method

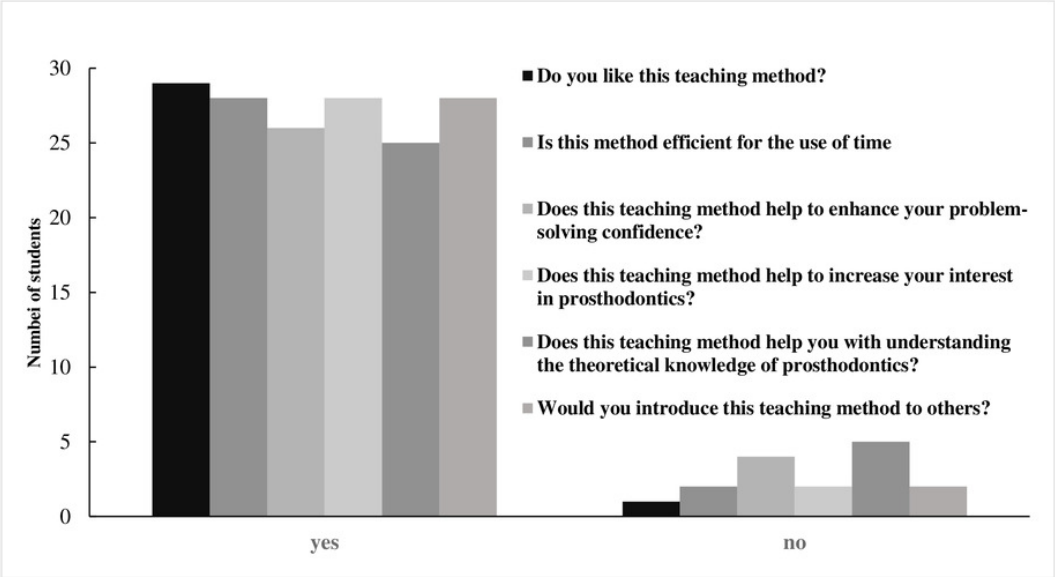
30
25
20
15
10
5
0
Numbei of students
yes
no
Do you like this teaching method?
Is this method efficient for the use of time
Does this teaching method help to enhance your problem-solving confidence?
Does this teaching method help to increase your interest in prosthodontics?
Does this teaching method help you with understanding the theoretical knowledge of prosthodontics?
Would you introduce this teaching method to others?

Figure 4

Student responses to the question: How did you find the value of this teaching method, as compared with that of the traditional teaching?

The figure4 shows that student responses to the question: How did you find the value of this teaching method, as compared with that of the traditional teaching?

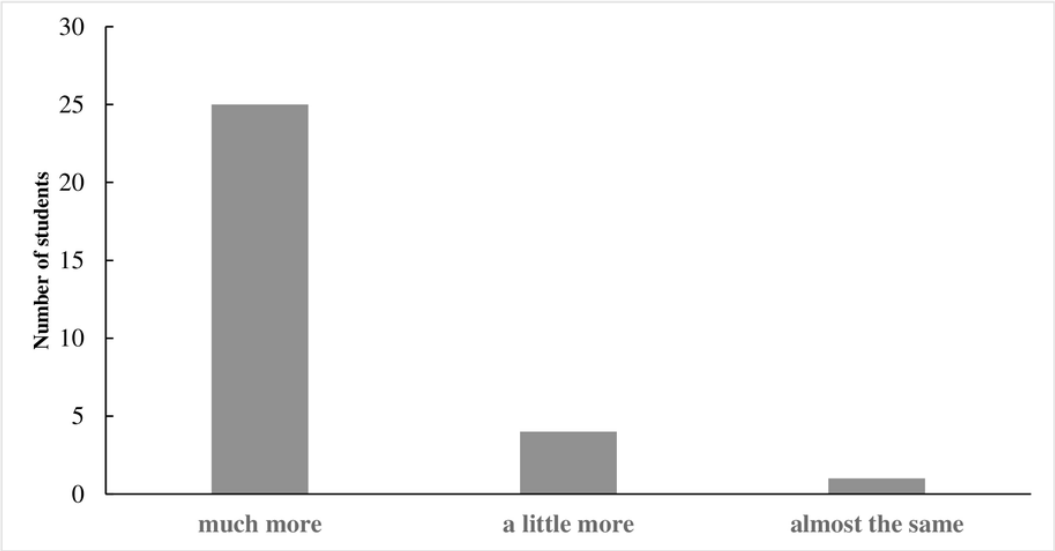
30
25
20
15
10
5
0
Number of students
much more
a little more
almost the same

Figure 5

Paper examination results of the clinical-simulation PBL training group and the control group

The figure shows that paper examination results of the clinical-simulation PBL training group and the control group

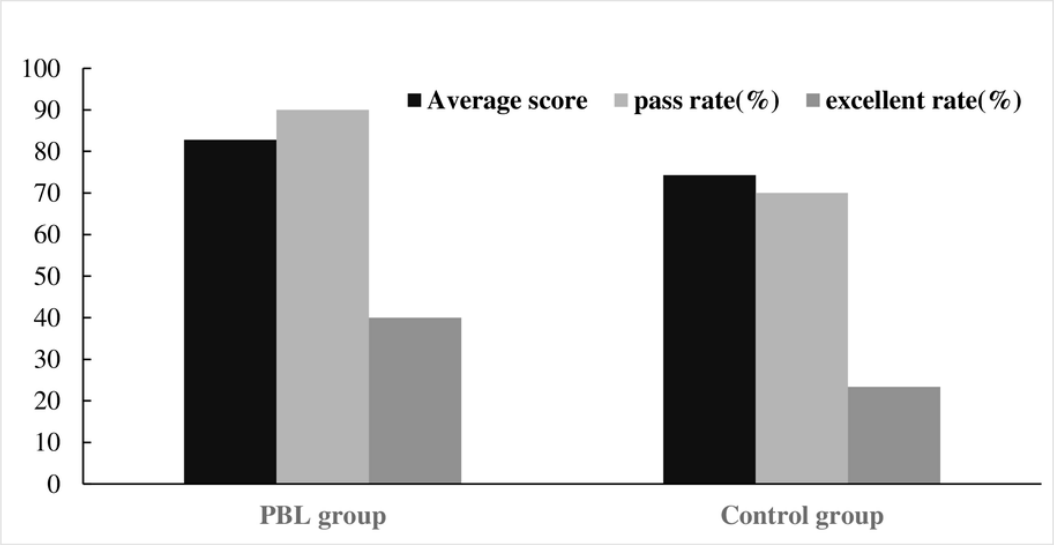
100
90
80
70
60
50
40
30
20
10
0
Average score
pass rate(%)
excellent rate(%)
PBL group
Control group

Table 1(on next page)

Score sheet for clinical practice

The table shows that score sheet for clinical practice

1 **Score sheet for clinical practice**

Items and scoring rules	Scores (Max points)
1. Whether the appearance of the students meets the hygiene requirements. For example, whether the hat, mask, and glove are worn correctly.	5
2. Whether the students' attitude is pleasant when they face patients, and whether the speed of their speech is appropriate.	5
3. Whether the inquiry is detailed, whether the purpose and requirements of patients are understood, and whether the patients' urgent issues to be addressed and comprehensive history, including the history, drug allergies, etc., are collected.	15
4. When conducting oral preliminary examination, whether compliance with aseptic conditions is satisfactory, whether the mouth pulling action is gentle, and whether the chair position is appropriate.	5
5. Whether the oral examination is complete, comprehensive, includes a related repair inspection, includes the abutments, the gaps of missing teeth, the alveolar ridge and mucosa, occlusion, etc., and examination of other dental, periodontal, and mucosal conditions	15
6. Whether the auxiliary check is reasonable and comprehensive, whether the diagnosis of oral diseases is accurate and complete, and whether a reasonable differential diagnosis is conducted.	10
7. Whether the preliminary diagnosis is correct, whether the explanation of the oral condition is sufficiently detailed, and whether several possible treatment plans are developed, including any necessary collaborative treatments involving other departments.	15
8. Whether a reasonable treatment plan has been determined and described in detail	15

to the patients, including the desired treatment time, costs, possible problems, etc.	
9. Whether the case history record is comprehensive and standardized.	5
10. Whether the patients' recognition and satisfaction are received.	10
Total	100

2

3

Table 2(on next page)

Score results of the clinical simulation in the PBL training group and control group

The table shows that score results of the clinical simulation in the PBL training group and control group

1 Score results of the clinical simulation in the PBL training group and control group

Items	Average scores of the clinical simulation PBL training group (points)	Average scores of the control group (points)
1	4.63	3.45
2	4.33	3.12
3	14.17	9.27
4	4.47	2.87
5	14.53	11.12
6	9.00	8.03
7	9.03	7.00
8	14.73	12.20
9	4.47	3.41
10	9.53	6.80
Total points	88.89	67.27

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