A Comparative Study on Problem-Based Learning Online/Offline Teaching Methods During the Covid-19 Epidemic -A Case Study of Undergraduate Periodontology Teaching

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Abstract

Objective: This article aimed to compare the education effectiveness of online/offline PBL teaching methods and provide new ideas for the improvement of PBL teaching mode in dental education. **Methods:** In the periodontology course, 124 stomatology students in the 2017 and 2018 grades at the College of Stomatology at Jinan University were randomly divided into two groups: online PBL teaching group and offline face-to-face PBL teaching group. The teacher issued the same cases and questions to the two groups of students and asked students to discuss problems in small groups, retrieve literature and solve problems. PowerPoint reports and defense were also needed. After the course, a questionnaire survey was adopted to evaluate the application effect of online and offline PBL teaching modes, and the results were analyzed through SPSS software.

Results: Both groups of students were able to master their knowledge and improve their abilities well. However, Compared with the offline PBL teaching group, students in the online PBL teaching group showed higher satisfaction and better improvement of their literature retrieval ability and teamwork skills.

Conclusion: Compared with the offline PBL teaching mode, the online PBL teaching method is a more effective teaching method to gain students recognition and help dental students develop their literature retrieval ability and teamwork skills and to gain student recognition.

Keywords: problem-based learning, online education, educational methodology

1. Introduction

During the normalized prevention and control of COVID-19 in China, online teaching method has been widely adopted. Universities nationwide actively carry out online education activities to ensure teaching progress and quality during the normalized prevention and control of COVID-19. With the popularization and development of the Internet, the online education market has been developing rapidly, and the number of online education users has been rising (Hilburg, R., Patel, N., Ambruso, S., et al., 2020). According to the data of iResearch, the scale of online education users in China reached 309 million in 2020, and college students were important users of Internet devices. They can quickly adapt to the combination of emerging technologies and new education models (2020 China's Online Education Industry Repor 2020Q1&2020Q2e [C]//). Online education has become the first choice of teaching method for many universities during the epidemic. Online education is a trend of future teaching reform.

Unlike the traditional face-to-face offline teaching mode, online education is popular among teachers and students because of its advantage of not being restricted by space (Sun, A., & Chen, X., 2016).

Problem-Based Learning (PBL) teaching mode is a problem-centered and student-discussion-oriented educational approach, which mainly focuses on problem formulation, hypothesis creation, data collection and analysis around a topic through group discussions, and ultimately achieving the goal of problem-solving (Savery, J. R., 2006). This learning approach can improve students' independent learning and collaborative problem-solving skills, which is a popular teaching method internationally. It has received increasing attention in recent years and is widely used in medical education in China (Liu, Y., Xu, Y., Li, Y., et al., 2020; Wang, H., Xuan, J., Liu, L., et al., 2021). By applying PBL teaching approach in medical education, students can seek knowledge through cases, ask questions on their own, collectively discuss, and solve the problem to achieve the purpose of learning knowledge (Hmelo-Silver, C. E., 2004).

In order to further promote the development of online PBL teaching approach, this study selected 2017 and 2018 undergraduate stomatologists from the College of Stomatology at Jinan University as the objects of study. For the fourth-year compulsory course—Periodontology, online and offline PBL teaching approaches were conducted simultaneously. After class, the application effect of online and offline PBL teaching modes was evaluated through questionnaires, which is expected to provide new ideas for improving PBL teaching approach of stomatology courses in the future.

2. Methods

2.1 Objects and Methods

In this study, the independent sample contrast method was adopted, and a total of 124 stomatology students in the 2017 and 2018 grades at the College of Stomatology at Jinan University were selected as the objects of study. All students were enrolled in full-time undergraduate higher education, and there was no significant statistical difference among the students in admission scores, age, gender, etc. ($P>0.05$). All students experienced the online and offline PBL teaching modes and agreed with the method of this research. Before the course, students were randomly divided into an online PBL teaching group and an offline face-to-face PBL teaching group.

2.2 Application of Online and Offline PBL Teaching Modes

The fourth-year compulsory course called "Periodontology" was selected for the online and offline PBL teaching plan design, and a total of 9 class hours were arranged for three times of PBL case teaching sessions, with each session lasting for three hours. The PBL teaching typical cases prepared by the teachers in the Department of Stomatology of our school were the same in two groups of students, and the teacher was the same person. The teaching schedule is unified, which was arranged after the corresponding theoretical knowledge was taught.

The course was prepared by the teacher in a unified manner, and its main content was to discuss the key points and difficulties of the case collectively. The online PBL teaching group used Tencent Conference APP, and each small group of students made PowerPoint reports and defense in turn; The offline PBL teaching group adopted the form of a face-to-face classroom and live PowerPoint reports and defense. The specific application process and PBL case design are shown in Figure 1.

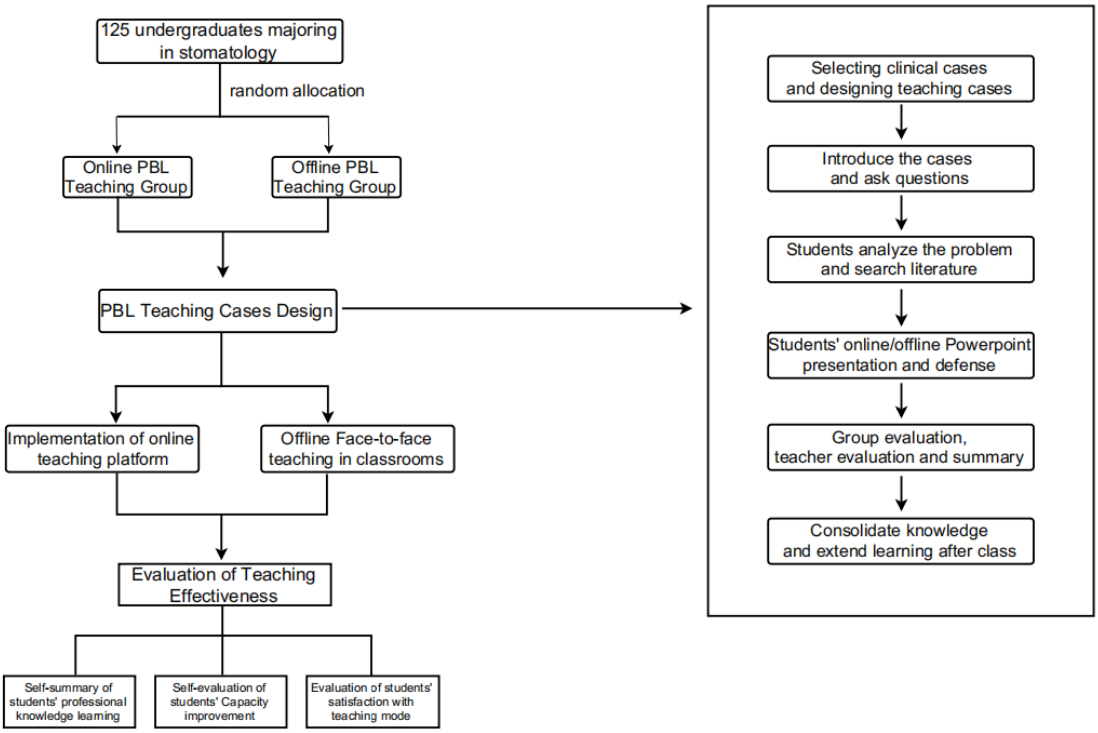

Figure 1. Application process of online and offline PBL teaching modes and PBL case design

2.3 Evaluation of Teaching Effectiveness

After the teaching was completed, anonymous votes were taken to evaluate the teaching effectiveness of the two groups of students. The survey included the students' summary of professional knowledge learning, students' evaluation of capacity improvement, and students' satisfaction with teaching mode. The Self-summary of students' professional knowledge learning was divided into three levels: good, average, and poor, mainly in terms of knowledge, ability, and quality objectives. It included the benefit from problem-solving and knowledge of your specialty, the profit from problem-solving and knowledge of your related specialty, the significance of diagnosis and differential diagnosis of diseases, and the significance of treatment and prognosis of diseases. Besides, the students' summary of their capacity improvement was divided into three levels: able, partially able, and unable, mainly in terms of problem analysis, problem-solving, linking theory with practice, etc. It included the improvement of your analytical and problem-solving ability, the improvement of your practical application of theoretical knowledge, the improvement of your literature retrieval ability, the improvement of your understanding of the doctor-patient relationship, and the improvement of your teamwork ability. Students' satisfaction with the teaching mode was evaluated mainly in terms of teaching content, teaching effect, and teaching attitude, and it was divided into three levels: satisfied, basically satisfied, and dissatisfied. It included recognition of this teaching, satisfaction with the teacher, improvement of your clinical thinking, the benefit of this teaching mode compared with the general teaching mode, whether this teaching mode stimulates your interest in learning, and whether this teaching is suitable for application in clinical teaching.

2.4 Statistical Methods

SPSS Statistics 20 was used to statistically analyze all the survey data. The Mann-Whitney U rank-sum test was used to evaluate the results of the rank data, and $P < 0.05$ indicated that the differences were statistically significant.

3. Results

3.1 Self-summary of Students' Professional Knowledge Learning

A total of 124 questionnaires were sent to the two groups of students, and all of them were received (response rate 100%). The results are shown in Table 1. The results of the survey on the summary of professional knowledge learning showed that there were no statistically significant differences between the online and offline PBL groups in

the following four areas (P > 0. 05). These were the benefit from problem-solving and knowledge of your specialty (Z = -1.659, P = 0.098), the profit from problem-solving and knowledge of your related specialty (Z = -1.330, P = 0.186), the significance of diagnosis and differential diagnosis of diseases (Z = -1.534, P = 0. 0.125), and the significance of treatment and prognosis of diseases (Z = -1.557, P = 0.111).

Table 1. Self-summary of students' professional knowledge learning

Evaluating index	Online groups (n=62)			Offline groups (n=62)			Z	*P*
	good	average	poor	good	average	poor		
The benefit from problem-solving and knowledge of your specialty	37	14	11	45	11	6	-1.659	0.098
The benefit from problem-solving and knowledge of your related specialty	31	22	9	41	14	7	-1.330	0.186
The significance of diagnosis and differential diagnosis of diseases	34	18	10	38	14	10	-1.534	0.125
The significance of treatment and prognosis of diseases.	32	18	12	39	16	7	-1.557	0.111

3.2 Self-evaluation of Students' Capacity Improvement

A total of 124 questionnaires were sent to students in the two groups, and all were received (response rate 100%). The results are shown in Table 2. There were statistically significant differences (P < 0.05) between the online PBL group and the offline PBL group in terms of literature retrieval skills (Z = -2.468, P = 0.014) and teamwork skills (Z = -2.258, P = 0.024); However, there were no statistically significant difference between the online and offline PBL groups in terms of analytical and problem-solving skills (Z = -1.350, P = 0.177) and the practical application of theoretical knowledge (Z = -1. 220, P = 0.223), (P > 0.05).

Table 2. Self-evaluation of students' capacity improvement

Evaluating index	Online groups (n=62)			Offline groups (n=62)			Z	*P*
	good	average	poor	good	average	poor		
The improvement of your literature retrieval ability	40	15	7	32	19	11	-2.468	0.014
The improvement of your teamwork ability	42	14	6	32	18	12	-2.258	0.024
The improvement of your analytical and problem-solving ability	38	15	9	35	15	12	-1.350	0.177
The improvement of your practical application of theoretical knowledge	38	14	10	36	16	10	-1.220	0.223

3.3 Evaluation of Students' Satisfaction With Teaching Mode

A total of 124 questionnaires were sent to the two groups of students, and all of them were received (response rate 100%). The results are shown in Table 3. Compared with the offline PBL teaching group, students in the online PBL

teaching group showed higher satisfaction in these aspects involved recognition of this teaching (Z = -2.057, P = 0.040), satisfaction with the teacher (Z = -2.196, P = 0.028), improvement of clinical thinking (Z = --2.049, P = 0.040), the benefits of this teaching mode compared with the general teaching mode (Z = -3.298, P = 0.001), whether this teaching mode stimulates their interest in learning (Z = -2.635, P = 0.008), whether this teaching is suitable for application in clinical teaching (Z = -2.020, P = 0.043), and the differences were statistically significant (P < 0.05)

Table 3. Evaluation of students' satisfaction with teaching mode

Evaluating index	Online groups (n=62)			Offline groups (n=62)			Z	*P*
	good	average	poor	good	average	poor		
recognition of this teaching	43	17	2	34	17	11	-2.057	0.040
satisfaction with the teacher	47	14	1	33	16	13	-2.196	0.028
improvement of clinical thinking	45	17	0	35	16	11	-2.049	0.040
The benefits of this teaching mode compared with the general teaching mode	48	13	1	35	16	11	-3.298	0.001
whether this teaching mode stimulates their interest in learning	48	14	0	35	16	11	-2.635	0.008
whether this teaching is suitable for application in clinical teaching	48	14	0	36	16	10	-2.020	0.043

4. Discussions

Unlike traditional face-to-face PBL didactics, PBL online courses are mainly taught remotely with the help of the Internet. Few studies on PBL online didactics have been reported. Foreign scholars Nagge et al. ever evaluated PBL distance teaching mode by applying online software (Blackboard Collaborate © software), and the study showed that after overcoming software technology, online PBL didactics could obtain similar teaching effects as traditional PBL didactics (Nagge, J. J., Killeen, R., & Jennings, B., 2018). The domestic concept of online PBL didactics was first proposed in 2009, which believed that we can construct and apply an online teaching platform mainly including four major functions: course management, resource management, online collaboration, and result evaluation, thus realizing the teaching reform of online PBL (Wei, H., Wu, T., Ma, N., et al., 2014). In the past, online PBL didactics mostly belonged to pilot exploration, while online teaching mode is now fully applied in practice. The main platforms applied at this stage in China include the Rain Classroom, a new intelligent teaching tool co-launched by Tsinghua University and Xuetang online; Tencent Conference, a cloud-based video conferencing platform for audio and video communication; and DingTalk, a multi-terminal platform built by Alibaba, etc. The teaching quality of PBL online teaching mode is still inconclusive due to the influence of audio and video quality. Therefore, it is both an opportunity and a challenge to study and use the PBL teaching mode based on the Internet and summarize the teaching experience.

The combination of online and offline PBL learning mode can help improve students' interest in learning, stimulate learning motivation, and cultivate learners' independent learning abilities. The traditional lecture-based PBL teaching mode puts students in a passive state of receiving knowledge, which confines students' subjective initiative and the development of innovative thinking. In addition, under the background of exam-oriented education, grades become the primary index for measuring students' learning outcomes, which makes medical students focus on memorization and pursue high scores in the learning process, neglecting the cultivation of comprehensive quality and the enhancement of practical ability in the learning process. The thinking process shown in PBL teaching mode is based on the problem and scenarios, gradually deepening and expanding layer by layer, which turns tasteless rote

memorization into suspenseful exploring and uncovering of knowledge, thus making it more interesting and more accessible to stimulate students' curiosity (Chen, N.-C., 2008; Norman, G. T., & Schmidt, H. G., 1992). The results of the questionnaire survey also showed that the majority of students approve of this teaching reform. They were satisfied with the course and generally felt that the online and offline PBL teaching modes can stimulate students' interest in learning, which makes it suitable for promotion and application. Besides, PBL teaching mode focuses more on the whole process of learning and monitors and evaluates the whole process, thus changing summative assessment into formative assessment, which can assess students' learning effect more comprehensively and reflect students' learning problems more carefully. Therefore, the PBL mode is more conducive to improving students' initiative and conscientiousness in learning and developing the habit of independent learning (Miflin, C. P., 2000; Finucane, P. M., Johnson, S. M., & Prideaux, D. J., 1998). What's more, PBL didactics requires a combination of independent learning and team learning. In the process of analyzing the case problem, students have to seek knowledge independently, consult the literature, and make study notes, but also listen to peers' speeches, conduct team communication and reporting, and share the results of collective wisdom. This effectively exercises students' independent learning ability, expression ability, assistance ability, and practical operation ability so that the overall quality of learners can be improved (Choi, J.-S., Bae, S.-M., Shin, S.-J., et al., 2022).

The online learning approach during COVID-19 is not merely a temporary expedient but a historical necessity. Advances in the level of science and technology have led to easier access to teaching and learning resources. As teaching methods and tools become more diverse, teaching systems also provide a whole new platform to support teachers in their educational and teaching duties. The emergence of new teaching models not only provides opportunities for improving education and teaching but also poses higher requirements and challenges. Combining this research practice with a review of peer teaching experience, we now summarize the following recommendations:

1) Interpersonal interaction and collaboration between teachers and students are the core of PBL education (Amerstorfer, C. M., & Freiin von Münster-Kistner, C., 2021). The Internet has not fundamentally changed the education model, and the Internet era requires a new form of redefining teacher-student relationships. With more diversified information sources, realizing the education and teaching model of teacher-student participation, mutual collaboration, and joint promotion to build democratic, equal, and harmonious interpersonal relationships is the most unique and exciting part of promoting PBL teaching mode. The development of new types of leadership skills (as chairperson), communication skills (as a group member and recorder), teamwork, interpersonal relation, and independent thinking skills through online PBL didactics is significant for students to better participate in clinical practice and even integrate into society (Bridges, S., McGrath, C., & Whitehill, T. L., 2012). 2) The role of teachers and the competencies required in the Internet era should be properly examined and defined. Teachers should not only improve their scientific and humanistic literacy and be psychologically prepared to accept online supervision at all times, but also strengthen their adaptation training to new teaching modes so as to reduce the discomfort and anxiety caused by the sudden intervention of new technologies and methods. 3) Strengthen the protection of intellectual property rights in live online teaching. Live online teaching is more open compared to traditional teaching, and it also faces more possibilities of property rights infringement, such as the important intellectual property rights of teachers, the patient privacy preserving in doctors' cases, etc (Fast, I., Sorensen, K., Brand, H., et al., 2015). When online education is normalized, it is essential to learn and dabble in the corresponding knowledge about intellectual property rights, privacy preserving, and even general law knowledge. 4) Seeking alternative solutions when the online teaching network is interrupted. When live teaching is suspended for some reason, how to smoothly adopt Option B is also an area where online classroom teaching can be considered for improvement.

5. Conclusion

Although there are some problems with the online PBL teaching mode, it can better help dentistry students master professional knowledge and develop students' comprehensive ability. The online PBL teaching mode can effectively improve students' independent thinking, problem-solving, searching information, and integrating information abilities. Besides, this teaching mode also exercises students to boldly express their opinions in group discussions, which makes students master and consolidate professional knowledge through discussion of cases.

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