Impact of the Blended Teaching Model on Learning Outcomes

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Abstract—Blended teaching and other information teaching models promote a new type of teaching revolution and enhance the interaction and communication among teachers and students. However, most colleges and universities still adopt the traditional teaching model where students' learning efficiency and quality are relatively low with teachers' spoon-feeding delivery. The Bridge–Objective–Bridge–Pre-assessment–Participatory Learning–Post-assessment–Summary (BOPPPS) model advocates showing students clear learning objectives in leaning to form a learning objective-oriented model. The Presentation–Assimilation–Discussion (PAD) Class is conducive to cultivating learners' high cognitive levels; in the presentation session, teachers simply refine and explain the framework and key points to help learners build a knowledge network. Based on BOPPPS and PAD Class models, a 15-week blended teaching experiment was conducted in the Computer Technology Translation course in Harbin Normal University of China. Results show that the significant p-value corresponding to the t-value of the pretest scores of control and experimental groups is 0.255, greater than 0.05, which is in line with the basic premise of this teaching experiment; the mean values of the posttest scores of students in the experimental and control groups of the paired-sample t-test are significant at 1% and 10% significance levels, compared with the mean values of pretest scores, respectively; in the traditional teaching model, female students tend to demonstrate more learning advantages than male students, whereas no difference is observed in the learning outcomes between males and females in the experimental group. Thus, the adoption of BOPPPS and PAD Class models can enhance the learning outcomes of males and females. Our findings provide new ideas and methods for deepening the development of the theoretical basis of PAD Class, expanding the perspective and application of BOPPPS and improving students' learning enthusiasm and classroom participation effectively.

Keywords—BOPPPS, PAD Class, blended teaching model, learning outcome, ANOVA, independent sample t-test, paired sample t-test

1 Introduction

With the rise of Massive Open Online Courses (MOOC) and Small Private Online Course (SPOC), a large number of online open courses have emerged, which provide new ideas for higher engineering education. Blended teaching is a new product of

education with the development of modern information technology (IT). Blended teaching is a kind of "online + offline" teaching that combines the advantages of online teaching and traditional teaching; through their organic combination, students' learning can deepen. As the COVID-19 pandemic is sweeping the world, all Chinese schools must change offline teaching to online teaching to ensure students' health and safety. In online teaching sessions, teachers should interact actively and develop together with students; balance the relationship between imparting knowledge and cultivating ability; focus on cultivating students' independence; and guide them to question, investigate, and inquire. In offline teaching sessions, students are promoted to learn actively and individually under teachers' guidance. Communication between teachers and students can transform teachers from classroom managers to students' instructors, classroom participants, and students' partners. Along with the new round of curriculum reform, the roles and statuses of students and teachers in classrooms have attracted further attention and focus. Today's classroom teaching increasingly emphasizes the equal relationship between teachers and students. It also pays further attention to students' experiences, emotions, teacher–student interactions, and teachers' guidance and motivation to students. In the teaching process, a good interactive relationship between teachers and students is an important way to improve teaching quality, which helps to stimulate and cultivate students' enthusiasm and interest in learning. However, the traditional teacher-oriented teaching approach affects students' learning enthusiasm and restricts their creativity.

The Bridge – Objective – Bridge – Pre-assessment – Participatory Learning – Post-assessment – Summary (BOPPPS) model is a student-oriented and student-centered teaching model. It is an efficient and effective interactive teaching model. Through the practice of some Chinese scholars, BOPPPS has been confirmed to play a good role in facilitating teacher–student interactions in online classrooms. The new BOPPPS teaching model is suitable for IT classroom teaching to improve "ineffective" or "inefficient" interactions between teachers and students in classrooms and to achieve quality teacher–student interactions. The core concept of Presentation–Assimilation–Discussion (PAD) Class is to divide the power and responsibility between teachers and students, emphasizing teacher leadership and student individuality and combining the advantages of two teaching modes: lecture and discussion. In traditional teaching, teachers generally adopt the teacher PowerPoint lecture mode and students lack operation. Therefore, communication between teachers and students is rare and students are in a passive state of receiving knowledge, thereby lacking effective participation and initiative. This immediate operation violates the basic law of educational psychology, where students cannot understand the new knowledge and no time is given to digest and absorb such knowledge. Then it is difficult for students to form new ideas and ask profound questions. Therefore, BOPPPS and PAD Class are used to apply to blended teaching. In online learning sessions, students can strengthen their learning basis by watching videos or graphic materials from online learning platforms designated by their teachers. In offline classroom sessions, teachers use problem-oriented teaching, which is important to develop students' independent learning skills and critical thinking skills. The blended teaching model based on BOPPPS and PAD Class can stimulate students' own initiative, balance the relationship between teaching and learning, increase students' independent learning time by reducing teachers' lecture time and just providing the framework, create a digital learning environment for students and enhance students' learning outcomes.

2 Theoretical foundation and literature review

2.1 Theoretical foundation

In 1978 BOPPPS was proposed at Columbia University in Canada. Research on the BOPPPS teaching model can help teachers to understand the effective teaching strategies and improve teaching interactions. BOPPPS teaching model consist of bridge, objective, pre-assessment, participatory learning, post-assessment, and summary, which makes classroom teaching more modular than usual. It provides a complete framework for classroom teaching and a comprehensive theoretical support to make the classroom arrangement orderly and reasonable. The implementation of BOPPPS and the addition of a series of interactive strategies can help students to improve their self-efficacy and classroom participation and enjoy the further interaction with their teachers. In this way, they can master systematic IT knowledge and translation skills more firmly than before. BOPPPS teaching model advocates presenting students with clear learning objectives in teaching and learning, adopting a "teacher-leading and student-participating" approach throughout the teaching activities, and forming an objective-oriented learning model, which are conducive to the students' transformation from passive learning to active learning. Moreover, BOPPPS helps students improve their independent learning ability and teamwork consciousness in the process of participatory learning, which is in line with the national reform requirements for higher engineering education.

PAD Class was first proposed by Professor Zhang Xuexin in Fudan University in the spring of 2014, which integrates the advantages of various teaching methods and has a solid theoretical foundation [1]. Later, it has been widely applied in the experimental research on multi-level and multi-course teaching in China. PAD Class is a unique combination of constructivism and traditional teaching models, emphasizing the independent constructive nature of learning and the interactive nature of teaching. In PAD Class model, half of the class time is allocated to teacher lectures and the other half to student discussions. It focuses on teaching before learning, namely teacher lectures first and student learning second and emphasizes student–student interactions and teacher–student interactions in order to encourage independent learning. PAD Class divides teaching into three interrelated processes: teachers' classroom lecture (presentation), students' post-class internalization (assimilation), and students' classroom discussion (discussion). The key innovation of PAD Class is to separate lectures from discussions. In this way, students have some time in between to arrange their own learning, personalize their internalization and assimilation and reinforce earning outcomes in the forms of discussions and assignments.

2.2 Literature review

In order to enable novice teachers to improve their teaching skills quickly in a short period of time, the Canadian Teacher Skills Training Workshop proposed the BOPPPS teaching model. The PAD Class is a new teaching model proposed by local Chinese scholars in recent years. It takes presentation, assimilation and discussion as the basic operation steps and follows the teaching concept of "student-centered". Lou et al. [2] demonstrated how BOPPPS and Theory of the Solution of Inventive Problems (TRIZ)

affect students' learning outcomes through an experiment at a university in Taiwan. The experimental group adopted "TRIZ-integrated BOPPPS" teaching strategy for testing and the results show that "BOPPPS and TRIZ" strategies are very effective in cultivating students' creativity and collaborative learning. Hu et al. [3] conducted a comparative study between BOPPPS and traditional thoracic surgery teaching approaches and showed that BOPPPS has advantages over the traditional one and BOPPPS can make it easy for medical students to become familiar with thoracic surgery-related procedures. Yu and Fang [4] argued that the application of BOPPPS to teacher training is effective, and similar approaches can be applied to Chinese teachers' pre-job training with the help of BOPPPS. Shih and Tsai [5] performed a quasi-experimental study of students from a business etiquette course. A comparison experiment was conducted with 77 students from two classes. The results indicated that students in the experimental group outperformed those in the control group in terms of learning outcomes. The experimental group had better perceptions than the control group in terms of teacher instruction and skill learning. Moreover, the BOPPPS approach led to further teacher–student interactions and lively classes. Therefore, it has a significant influence on improving students' learning outcomes. Guo et al. [6] showed that BOPPPS applied to the embedded systems design for basic higher education courses can significantly enhance learners' propensity and outcomes. Chung et al. [7] applied the BOPPPS teaching strategy to creative project development and set creative design as the criteria. BOPPPS was found to have a significant and positive effect on creative learning among college students. Yu et al. [8] observed the clinical teaching effect of BOPPPS in the standardized training of resident doctors for postgraduates of Traditional Chinese Medicine (TCM) surgery. The results showed that the BOPPPS teaching model can improve residents' ability to master professional knowledge and skills in the standardized training of TCM surgery postgraduates. Li [9] conducted an experimental study on Internet Marketing course with the BOPPPS teaching model. The findings revealed that the "cloud classroom + BOPPPS" model is an effective blended online and offline teaching method. Lei [10] analyzed the BOPPPS model in the teaching design of the Web Development Technology course. The results showed that BOPPPS can be effectively applied in teaching. Qi [11] explored the role of English teachers in classrooms in the PAD Class. English teachers were found to play a wide range of roles to meet students' needs and make contributions to language learning. Luo et al. [12] showed that the PAD Class based on the educational cloud platform is beneficial to students' learning abilities and has a positive impact on their interest in learning, classroom participation and knowledge application skills. It can be seen from the existing research literature that BOPPPS can create a free, open and democratic classroom, which is more conducive to the overall development of learners. The diversified evaluation pays attention to the process evaluation, which not only has the quiz assessment in the traditional teaching assessment but also integrates various elements, such as learner homework completion, class discussion, group leader evaluation and independent evaluation, which are beneficial to form an overall and objective assessment. A timely, diversified and objective evaluation is conducive to learners' sense of efficacy and motivates them to learn more diligently than before. The essence of PAD Class is to add assimilation to teachers' lectures and students' discussions so that learners can participate in the discussion with adequate preparation and independent thinking. In this way, learners

can be well-prepared for the following discussions, improve discussion enthusiasm and efficiency, and thus enhance the teaching effect. The present study adopts the experimental research method, which is based on the theoretical basis of the BOPPPS and PAD Class. This work also applies the experimental process in Harbin Normal University's "Computer Technology Translation" course. Two classes with similar academic conditions are selected to test whether there are differences in learners' learning outcomes between BOPPPS and PAD Class model and traditional lecturing class. Through experimental research, the experimental hypothesis is verified and the theoretical basis of teaching is elaborated and further analyzed, so as to supplement and improve the theoretical framework of PAD Class in teaching practice.

3 Methodology

3.1 Research subject

A total of 140 students from Harbin Normal University were involved in this comparative teaching experiment. Taking the "Computer Technology Translation" course as an example, students were randomly divided into two teaching classes of 70 each, including 12 female students and 58 male students. Among them, students in the experimental group introduced BOPPPS and PAD Class model for blended teaching in the specific teaching process. Meanwhile, students in the control group were taught in the traditional way. The 15-week experiment was performed in the spring semester of the academic year 2021–2022. Both groups were taught by the same teacher without affecting the original normal teaching.

3.2 Experimental process

First of all, a pretest of the students' performance in the two classes was conducted. It is important in the blended teaching process, as it can strengthen interactions between teachers and students on the one hand and is a yardstick to test the effectiveness of students' online learning before class on the other hand. We designed 100 multiple-choice questions on computer technology translation, each with one point, and used an online learning application to publish them in the classroom, asking students to finish them within 20 minutes and obtaining their pretest scores according to the statistics displayed in the application. Subsequently, teaching experiments were performed in the control and experimental groups. In this environment, about half of the time was spent on the teacher's intensive lectures, including the decomposition and analysis of computational thinking problems and translation skills. As opposed to pre-class online learning, half of the classroom teaching time focuses on the key knowledge and difficult skills, while the other half on students' practice, discussion and demonstration, allowing students to show their learning outcome in an overall and reasonable way. Finally, a posttest of students' performance was conducted to test students' learning effect in time, which was completed offline in the final exam of Computer Technology Translation course. Therefore, students' scores were used as posttest performance values to indicate their learning outcomes.

4 Result analysis

4.1 Comparison of pretest scores between control and experimental groups

First, an independent sample t-test was conducted on the pretest results of experimental and control groups. Table 1 shows that the significant p-value corresponding to the t-value of the pretest results of control and experimental groups is 0.255, all of which are greater than 0.05 and do not reach the significance level. Thus, no significant difference exists between the pretest results of experimental and control groups. Moreover, the students' level of basic computer knowledge and translation skills in the two classes are relatively close to each other, ensuring that in the experiment, both groups only have different teaching modes, in line with the basic premise of this teaching experiment.

Table 1. Independent sample t-test of the pretest scores of control and experimental groups

Sample	Standard Deviation	Mean Standard Error	t	P
Pretest Score of the Experimental Group	2.86	0.34	1.14	0.255
Pretest Score of the Control Group	3.15	0.38		

4.2 Analysis of the pretest and posttest scores of the control group

Table 2 presents that the mean value of students' posttest scores in the control group is 0.903 larger than that of their pretest scores, which is only significant at the 10% significance level. Therefore, the traditional teaching model adopted by the students in the control group is less suitable for online and offline blended teaching. Possible reasons may lie in the fact that the traditional teaching mode is not flexible, scalable, and open, which can lead to insufficient interactions between teachers and students, weaken the depth and precision for knowledge transfer, and pay insufficient attention to students' knowledge absorption and mastery. Specifically, "Computer Technology Translation" is a course that requires students' strong hands-on ability. The traditional teaching model does not consider the hands-on ability and simply focus on the theories, so that the learners' learning results are not significantly improved.

Table 2. Paired sample t-test for the pretest and posttest scores of the control group

Sample	Mean	Standard Deviation	Mean Standard Error	t	P
Pretest Score of the Experimental Group	59.330	3.148	0.376	−1.97	0.053*
Posttest Score of the Control Group	60.233	2.266	0.271		

Note: * indicates significance at the 10% level.

4.3 Analysis on the pretest and posttest scores of the experimental group

Figure 1 illustrates that the posttest scores of students in the experimental group adopting BOPPPS plus PAD Class model are higher than their pretest scores, which are significant at the 1% level. The main reason is that the experimental group adopts PAD Class model in "Computer Technology Translation" course to enrich IT teaching theory and translation skills. PAD Class realizes a change in teaching style, allowing teachers and students to share their previous authorities and responsibilities, adjusting the relationship between teaching and learning, and creating a digital learning environment for students to use IT and tools for independent learning. In such a situation, teachers' lecture time is reduced by providing framework knowledge and students' independent learning time is increased. Such independent learning can bring into play students' subjective initiative and well improve their digital learning and innovation ability. At the same time, BOPPPS can encourage students with good computer and translation skills to act as teaching assistants. Throughout the teaching process, students should be classified into different groups to discuss and solve problems and teachers should follow up the progress of each group member. It is easier for students to identify problems, ask questions, and solve problems in such group discussion. In the after-class online session, teachers instruct teaching assistants to explain operation procedures and answer difficult questions from students in WeChat groups based on students' classroom feedback. Therefore, a good interactive and mutually helpful atmosphere in class teaching is formed and an effective closed loop of online and offline blended teaching is realized. In addition, many online extension resources and operation materials are available for students to choose after class to broaden their horizons and meet their individual needs.

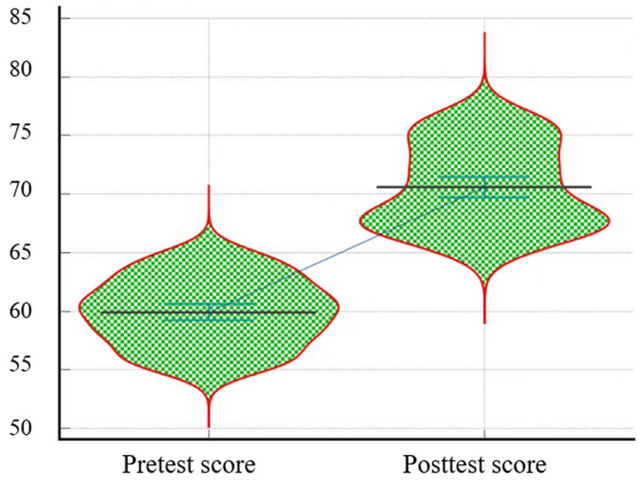

Fig. 1. Paired sample t-test of the pretest and posttest scores of the experimental group

4.4 Comparison of posttest scores between control and experimental groups

The independent t-test result in Table 3 presents that at the end of the 15-week teaching experiment the posttest scores of students in the experimental group (through the combination of BOPPPS and PAD Class) are better than those of students in the control group, with a p-value less than 0.01. Therefore, the BOPPPS plus PAD Class teaching model has a positive impact on learning outcomes. Moreover, the BOPPPS plus PAD Class model can further enable teachers to control classroom and student learning. Teachers can deliver knowledge in a targeted manner with the big data analysis results of the teaching platform, teach comprehensive knowledge online, focus on important and difficult points, give more initiative to students, ask more questions, and allocate reasonable time for each part of the offline teaching. In this way, students feel fulfilled and rewarded and thus enhance their interest in learning.

Table 3. Independent sample t-test for the posttest scores of control and experimental groups

Sample	Mean	Standard Deviation	Mean Standard Error	t	P
Posttest Score of the Experimental Group	70.60	3.55	0.42	15.18	0.000***
Posttest Score of the Control Group	61.19	3.78	0.45		

Note: *** indicates significance at the 1% level.

4.5 Analysis of gender difference

It can be seen from Table 4 that a significant difference exists in the posttest scores of male and female students in the control group. Teachers usually give lectures in the traditional teaching model, and female students prefer teachers' Computer Technology Translation lectures. Females improve their learning performances by taking notes and completing assignments in the traditional model. By contrast, male students show relatively little leaning motivation in the traditional teaching model. Therefore, female students have more learning outcomes than male students.

Table 4. ANOVA results of gender on posttest scores

Posttest Score	Adj SS	Adj MS	F	P
Control group	412.3	412.318	49.09	0.000***
Experimental group	34.03	34.03	2.77	0.101

Note: *** indicates significance at the 1% level.

As can be seen from Table 4 and Figure 2, there is no difference between boys and girls in the experimental group in the learning outcomes of the Computer Technology Translation course, indicating that the use of BOPPPS plus PAD Class model can improve the learning outcomes of boys and girls. Both models are novel and can enhance the common interests of boys and girls effectively, making them further willing to learn the core knowledge of the course. Moreover, teachers' teaching contents and activities in each part of the BOPPPS teaching model are clear. Some students

gradually develop the good habits of previewing before class, reviewing after class, and asking questions in time. Furthermore, students become more purposeful in their learning and more effective and efficient than before.

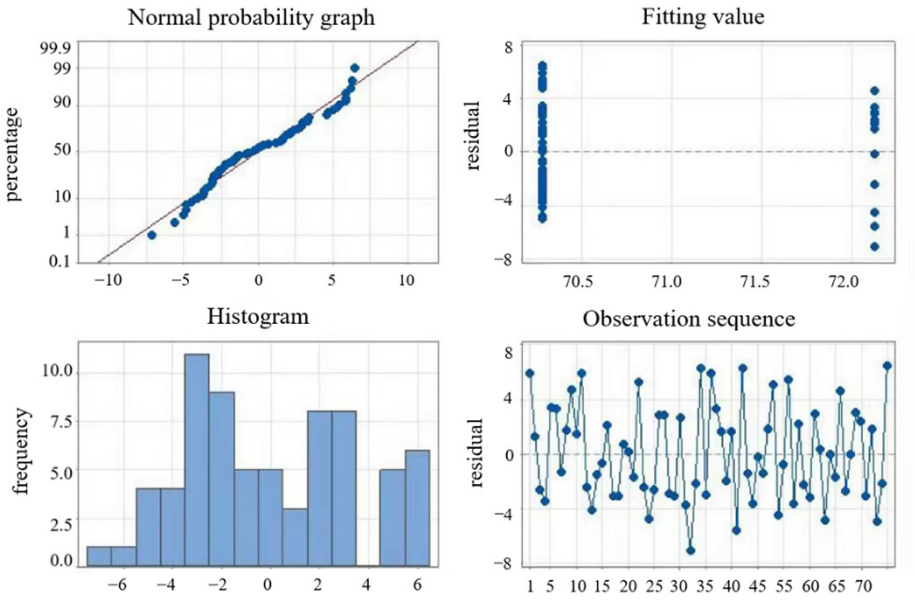

Fig. 2. ANOVA results of gender on posttest scores in the experimental group

5 Discussion

Through a 15-week teaching practice, the academic performances of the two groups are analyzed after the final examinations. The experimental group that implements BOPPPS plus PAD Class has significant improvements in scores, whereas the control group that utilizes the traditional teaching method has no significant change in scores. The BOPPPS plus PAD Class model improves students' learning outcomes in the Computer Technology Translation course. The BOPPPS model has a large feedback mechanism throughout the entire teaching process. Each step, including pre-assessment, participatory learning, post-assessment, and summary, allows students to reflect unconsciously [13]. The constantly updated experience and knowledge can clarify some basic concepts of computer-assisted translation, eliminate some misunderstandings in cognition, understand the basic principles of computer-assisted translation, and master the basic operations of various mainstream computer-assisted translation software and tools at home and abroad [14]. The application of PAD Class follows the procedure of presentation, assimilation, and discussion in a sequential and step-by-step manner. In the implementation process, attention should be paid to student inspiration and guidance to help them improve computational translation efficiency and competence [15]. Through independent assimilation and discussion, breakthroughs are achieved in accurate term extraction, translation database retrieval function, translation quality improvement, and

deep knowledge understanding and application [16]. BOPPPS plus PAD Class model allows students to implement targeted independent assimilation on the basis of teacher presentation, which conforms to the psychological development law and promotes learners to make a summary with a clear learning objective. In the PAD Class implementation, the sharing of excellent homework can help students learn from one another and gradually influence the application of learning strategies and develop their independent learning ability. Knowledge is conveyed in a vivid and concise way to attract students' attention, further stimulate their learning interests, and ensure high learning motivations. The PAD Class can also enhance teachers' teaching organization skills, such as organizing presentations, arranging appropriate assignments for assimilation, and promoting discussions in the next class. Therefore, teachers' professional competence can be cultivated and promoted in a continuous way.

6 Conclusions

Blended teaching combines the advantages of online teaching and face-to-face classroom teaching, which features in the unity of modernity and tradition, unity of autonomy and interactivity, and unity of knowledge and fun. It has a significant influence on improving students' learning outcomes. In this study, a 15-week blended teaching experiment was conducted in the Computer Technology Translation course in Harbin Normal University. The following conclusions were obtained:

(1) Compared with the mean pretest scores, the mean posttest scores of students in experimental and control groups are significant at 1% and 10% significance levels, respectively. The posttest scores of students in the experimental group who adopt the blended teaching based on the combination of BOPPPS and the PAD Class model are better than those in the control group taught in the traditional teaching approach.
(2) In the traditional teaching model, female students tend to show more learning advantages than male students, whereas no difference is found in the learning outcomes between males and females in the experimental group. Thus, the application of BOPPPS plus PAD Class model can enhance the learning outcomes of male and female students. Future works should increase the number of research objects, expand research on PAD Class, and improve the application of the BOPPPS teaching model.

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