Exploratory Application of the BOPPPS Model Combined with the Flipped Classroom Teaching Method in Physical Education

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Abstract: The effectiveness of combining the BOPPPS model with the flipped classroom teaching method in physical education has received widespread attention. To explore its impact on college students' physical fitness, mastery of volleyball techniques (specifically air volleyball), and psychological empowerment, this study employed an experimental design. A total of 84 students from two natural classes of the 2024 cohort at the School of Digital Business, Guangdong Polytechnic College of Posts and Telecommunications, were selected and divided by class. The experimental group adopted the "BOPPPS + flipped classroom" model, while the control group used the traditional "teacher demonstration–student practice" model over a 13-week period. Assessments included physical fitness tests, air volleyball skill evaluations, and psychological scale measurements to compare the effectiveness of the two teaching models. Results indicated no significant short-term improvement in physical fitness ($P > 0.05$), but the experimental model significantly enhanced students' mastery of volleyball skills and psychological empowerment ($P < 0.05$). The experimental group outperformed the control group in bumping, setting, and serving tests, and also demonstrated improved situational motivation, autonomous learning ability, and interest in physical education. These findings suggest that integrating the BOPPPS model with the flipped classroom can optimize physical education pedagogy, enhance teaching quality, and provide significant value in improving students' motor skills and learning motivation.

Keywords: BOPPPS Teaching Model; Flipped Classroom; Physical Education

1. Introduction

With the advancement of the "Healthy China 2030" strategy and the implementation of policies integrating sports and education, physical education in China is evolving toward greater diversification and specialization. Modern physical education requires not only the acquisition of sports skills and tactical knowledge but also the cultivation of interdisciplinary competencies, innovative thinking, and a lifelong awareness of physical fitness. However, traditional teaching models face challenges in adapting to these changes, such as unrealistic instructional settings, fragmented content, and delayed classroom feedback [1,2]. These limitations are particularly evident in the teaching of complex skills and injury prevention, where the integration of theory and practice remains inadequate. Although digital technologies like MOOCs and virtual simulations have been applied to physical education, issues persist, including mismatches between standardized resources and personalized needs [3], disconnections between online theoretical instruction and offline practical guidance, and difficulties in aligning real-time feedback with long-term skill development [4]. Balancing theory and practice while enhancing interactivity and effectiveness has thus become a key issue in physical education reform. The BOPPPS teaching model—which includes Bridge-in, Objective setting, Pre-assessment, Participatory learning, Post-assessment, and Summary [5]—when combined with the flipped classroom's principles of "pre-class knowledge acquisition and in-depth in-class internalization," offers a restructured approach to physical education. In this model, students preview sports principles via micro-lectures before class, engage in interactive inquiry during class to reinforce understanding, and carry out personalized

practice after class to consolidate learning. This study innovatively integrates the BOPPPS model with the flipped classroom approach, using air volleyball instruction as a case study to explore the transformation mechanism of "cognition–imitation–consolidation–innovation" in sports skill acquisition. It aims to provide a quantifiable and assessable implementation framework for physical education reform in the digital age.

2. Materials and Methods

2.1 Participants and Grouping

The study selected two natural classes from the 2024 cohort of the School of Digital Business at Guangdong Polytechnic College of Posts and Telecommunications, totaling 84 students. Class 2435 (Finance) served as the experimental group (42 students: 23 males, 19 females), and Class 2438 (Business Management) as the control group (42 students: 20 males, 22 females). The age range in the experimental group was 18–20 years (mean = 18.71 ± 0.67), while in the control group it was 17–21 years (mean = 18.71 ± 0.77). Prior to the intervention, there were no significant differences between the two groups in terms of physical fitness, air volleyball skills, situational motivation, interest in sports, or autonomous learning ability ($P > 0.05$), ensuring baseline comparability. The experimental group adopted the "BOPPPS + flipped classroom" teaching model, while the control group followed the traditional "teacher demonstration–student practice" method. Both groups received the same instructional content, duration (13 weeks, 26 class hours), facilities, and instructors. Classes were scheduled during the third and fourth periods in the morning to control for time-related variables.

2.2 Experimental Design

2.2.1 Variable Setting

Independent variable: Teaching method (the experimental group used the "BOPPPS + flipped classroom" model, while the control group followed a traditional teaching approach).

Dependent variables: Physical fitness (five indicators including 30-meter sprint and half-figure agility run), volleyball technique (performance in bumping, setting, and serving), and psychological indicators (sport situational motivation, interest in physical education, and self-directed learning ability).

2.2.2 Testing Indicators and Tools

(1) Physical fitness tests (based on the Guidelines for Volleyball Training and Education for Chinese Youth [6]): upper body strength (shuttlecock throwing), lower body strength (standing long jump), speed (30-meter sprint and half-figure agility run), and agility (cross-quadrant jumping).

(2) Volleyball skill tests (referencing the Volleyball Training Manual [7]): forearm passing (bumping), overhead setting, and serving (overhand for male students and underhand for female students).

(3) Psychological assessment scales (reliability and validity > 0.85): Sport Situational Motivation Scale [8], College Students' Interest in Physical Education Scale [9], and Self-Directed Learning in Physical Education Scale [10].

2.2.3 Experimental Controls

Homogeneity control: Baseline testing was conducted before the experiment to ensure no significant differences between groups ($P>0.05$).

Instructor control: The same instructor taught both groups to eliminate the influence of teaching style.

Environmental control: Classes were held at the same venue, with the experimental group scheduled on Monday during periods 3–4 and the control group on Tuesday during the same periods to reduce external interference.

2.3 Experimental Implementation Process

2.3.1 Pre-Test Phase (Week 1)

Both groups underwent testing in physical fitness (five indicators), volleyball technique (three skills), and psychological scales. The data were recorded and organized for analysis.

2.3.2 Instructional Intervention Phase (Weeks 2–12)

Experimental group (BOPPPS + flipped classroom model): In the pre-class phase, instructors created 5–8-minute microlectures (covering exercise principles, technical breakdowns, and learning objectives), uploaded them to the "Learning Pass" platform with drag prevention and speed

control features. Students watched the videos, completed pre-class assessments, and submitted questions, which were addressed via online Q&A sessions. During class, the BOPPPS framework was followed: (1) Bridge-in: Use of case studies or videos to stimulate interest and clarify learning and ideological goals; (2) Objective and Pre-assessment: Quizzes to check pre-class learning, along with error analysis; (3) Participatory Learning: Group practice, problem discussion, and peer assessment with teacher guidance; (4) Post-assessment: Skill demonstrations and mock games evaluated by peers and the instructor; (5) Summary: Recap of key knowledge points and assignment of after-class tasks. In the post-class phase, students uploaded practice videos, received personalized feedback, and engaged in online discussion forums—forming a complete learning cycle.

Control group (traditional teaching model): Followed conventional teaching procedures: warm-up, teacher demonstration, group training, corrective feedback, and final relaxation. No online resources or flipped classroom elements were involved. Pre- and post-class assessments were consistent with the experimental group.

2.3.3 Post-Test Phase (Week 13)

Post-tests were administered to assess physical fitness, volleyball technique, and psychological indicators. Changes before and after the intervention were compared to evaluate the effectiveness of the teaching model.

2.4 Statistical Methods

Data were analyzed using SPSS 26.0. Measurement data are presented as mean ± standard deviation (M±SD). Independent-sample t-tests were used for between-group comparisons, and paired-sample t-tests were used for within-group pre- and post-test comparisons. A significance level of $P<0.05$ was considered statistically significant.

3. Results

3.1 Longitudinal Comparison of Physical Fitness Training Outcomes Between the Experimental and Control Groups

As shown in Table 1, the experimental group exhibited significant improvements after the teaching intervention in semi-agility shuttle run ($T = 4.399$, $P = 0.000$), 30-meter sprint ($T = 3.702$, $P = 0.001$), long-distance shuttlecock throw ($T = -6.857$, $P = 0.000$), and quadrant jump ($T = 9.338$, $P = 0.000$), all with $P < 0.05$. However, no significant improvement was observed in the standing long jump ($T = -0.406$, $P = 0.687$), indicating that the BOPPPS model combined with the flipped classroom approach effectively enhances agility, speed, and upper limb strength, but has limited effect on lower-body explosive power.

Table 1 also shows that the control group achieved significant improvements in semi-agility shuttle run ($T = 3.925$, $P = 0.000$), 30-meter sprint ($T = 4.169$, $P = 0.000$), long-distance shuttlecock throw ($T = -7.258$, $P = 0.000$), and quadrant jump ($T = 7.464$, $P = 0.000$), with all P-values below 0.05. However, there was no significant change in standing long jump performance ($T = -0.731$, $P = 0.469$). These results suggest that the traditional teaching model can also improve speed, agility, and upper-body strength, though the degree of improvement in the 30-meter sprint, quadrant jump, and shuttlecock throw was lower than that in the experimental group, highlighting the superior effectiveness of the BOPPPS combined flipped classroom method.

Table 1. Pre- and Post-Test Results of Physical Fitness in the Experimental Group and Control Group (n = 42, M ± SD)

Group	Physical Fitness Indicator	Pre-Test (M ± SD)	Post-Test (M ± SD)	T	P
Experimental Group	5-meter shuttle movement	25.61±3.29	24.29±2.84	4.399	0.000
	30-meter sprint	5.45±0.78	5.03±0.68	3.702	0.001
	Badminton throwing distance	5.39±1.59	6.57±1.44	-6.857	0.000
	Standing long jump	192.98±30.36	193.62±30.80	-0.406	0.687
	Quadrant jump test	19.21±3.25	15.71±2.70	9.338	0.000
Control	5-meter shuttle movement	26.08±3.53	24.48±2.43	3.925	0.000

Group	30-meter sprint	5.64±0.62	5.26±0.75	4.169	0.000
	Badminton throwing distance	5.13±0.90	6.08±0.91	-7.258	0.000
	Standing long jump	187.38±33.75	188.95±34.13	-0.731	0.469
	Quadrant jump test	20.45±6.04	16.47±4.71	7.464	0.000

3.2 Intergroup Comparison of Intervention Effects: Post-Test Analysis Between the Experimental and Control Groups

As shown in Table 2, no statistically significant differences were found between the experimental and control groups in semi-agility shuttle run (T = -0.334, P = 0.740), 30-meter sprint (T = -1.148, P = 0.258), long-distance shuttlecock throw (T = 1.876, P = 0.068), standing long jump (T = 0.652, P = 0.518), and quadrant jump (T = -0.919, P = 0.363), all with P > 0.05. These findings indicate that the BOPPPS combined flipped classroom method is comparable to traditional teaching approaches in enhancing physical fitness.

Table 2. Post-Test Results of Physical Fitness in the Experimental and Control Groups (n = 42, M ± SD)

Physical Fitness Indicator	Experimental Group Post-Test (M ± SD)	Control Group Post-Test (M ± SD)	T	P
5-meter shuttle movement	24.29±2.84	24.48±2.43	-0.334	0.740
30-meter sprint	5.034±0.68	5.22±0.75	-1.148	0.258
Badminton throwing distance	6.57±1.44	6.08±0.91	1.876	0.068
Standing long jump	193.62±30.80	188.95±34.13	0.652	0.518
Quadrant jump test	15.71±2.70	16.47±4.71	-0.919	0.363

3.3 Analysis of Training Effects on Mastery of Volleyball Techniques

As presented in Table 3, the experimental group showed significant improvements (P < 0.01) in three volleyball techniques: bumping, passing, and serving. The bumping score increased from 13.81±3.95 to 38.02±19.17, passing from 20.02±11.57 to 74.57±11.39, and serving from 29.62±8.86 to 62.10±10.21. These results demonstrate that the BOPPPS model integrated with the flipped classroom method can effectively enhance students' volleyball skills.

During the same training period, the control group also experienced significant improvements in volleyball techniques (P < 0.01). The bumping score increased from 13.26±1.98 to 27.31±12.78, passing from 19.45±7.70 to 53.10±26.34, and serving from 31.33±10.23 to 48.07±15.40. Although traditional teaching methods promoted technical progress, the degree of improvement was smaller compared to the experimental group, indicating certain limitations in training effectiveness.

Table 4 shows that the post-test scores of the experimental group were significantly higher than those of the control group (P < 0.01): bumping (38.02±19.17 vs. 27.31±12.78), passing (74.57±11.39 vs. 53.10±26.34), and serving (62.10±10.21 vs. 48.07±15.40). This indicates that the BOPPPS model combined with the flipped classroom teaching method is more effective than traditional methods in enhancing volleyball skills.

Table 3. Pre- and Post-Test Results of Volleyball Performance in the Experimental Group (n = 42, M ± SD)

Group	Volleyball Skills	Pre-Test (M ± SD)	Post-Test (M ± SD)	T	P
Experimental Group	Bumping performance	13.81±3.95	38.02±19.17	-9.032	0.000
	Passing performance	20.02±11.57	74.57±11.39	-27.599	0.000
	Serving performance	29.62±8.86	62.10±10.21	-22.124	0.000
Control Group	Bumping performance	13.26±1.98	27.31±12.78	-6.991	0.000
	Passing performance	19.45±7.70	53.10±26.34	-8.333	0.000
	Serving performance	31.33±10.23	48.07±15.40	-10.241	0.000

Table 4. Post-Test Comparison of Volleyball Performance Between Experimental and Control Groups (n = 42, M ± SD)

Volleyball Skills	Experimental Group Post-Test (M ± SD)	Control Group Post-Test (M ± SD)	T	P

Bumping performance	38.02±19.17	27.31±12.78	3.147	0.003
Passing performance	74.57±11.39	53.10±26.34	4.627	0.000
Serving performance	62.10±10.21	48.07±15.40	5.248	0.000

3.4 The Effects of Different Teaching Models on College Students' Psychological Factors in Physical Education

Table 5 shows that the experimental group significantly outperformed the control group in terms of situational motivation, autonomous learning ability, and interest in physical education ($P < 0.05$), indicating that the BOPPPS model combined with the flipped classroom can effectively enhance students' psychological empowerment. The situational motivation score of the experimental group (3.68 ± 0.32) was significantly higher than that of the control group (3.41 ± 0.38, $P = 0.001$), suggesting that this teaching method can enhance students' motivation for physical education and encourage more active participation in sports. In terms of autonomous learning ability in physical education, the experimental group scored significantly higher (3.77 ± 0.43) than the control group (3.52 ± 0.52, $P = 0.017$). This indicates that the teaching method, through pre-class autonomous learning, in-class interaction, and feedback, strengthens knowledge acquisition and fosters students' self-management and initiative. In contrast, traditional teaching relies more heavily on instructor-led explanations, offering limited opportunities for students to develop autonomy. Regarding interest in physical education, the experimental group scored higher (3.78 ± 0.42) than the control group (3.52 ± 0.65, $P = 0.036$). This suggests that the flipped classroom model, through group discussions, interactive teaching, and hands-on activities, increases student engagement and stimulates interest in learning. In contrast, the traditional teaching model is relatively monotonous, leading to lower student participation and difficulty in maintaining interest.

Table 5. Post-Test Results of Psychological Variables in the Experimental and Control Groups (n = 42, M ± SD)

Psychological Variables	Experimental Group Post-Test (M ± SD)	Control Group Post-Test (M ± SD)	T	P
Motivation in sports situations	3.68±0.32	3.41±0.38	3.416	0.001
Autonomous learning in PE	3.77±0.43	3.52±0.52	2.441	0.017
Interest in physical education	3.78±0.42	3.52±0.65	2.142	0.036

4. Discussion

4.1 The Impact of the BOPPPS-Flipped Classroom Model on Physical Fitness

The results showed no significant differences between the experimental and control groups in the post-test of physical fitness indicators, indicating that the BOPPPS-flipped classroom model does not offer a marked advantage in improving physical fitness in the short term. Specifically, T-values for both groups in the T-test drill, 30-meter sprint, overhead shuttle throw, standing long jump, and quadrant jump did not reach statistical significance ($P > 0.05$). The flipped classroom approach emphasizes understanding and mastering techniques, whereas improvements in physical fitness typically require long-term training, making it difficult to observe significant changes in a short period. Moreover, individual training habits and baseline physical condition also influence the improvement of physical fitness. Therefore, future research should consider extending the intervention period or incorporating targeted physical fitness training to comprehensively evaluate its effects.

4.2 The Effect of the BOPPPS-Flipped Classroom Model on Mastery of Volleyball Skills

The post-test scores of the experimental group in bumping ($T = 3.147$, $P = 0.003$), setting ($T = 4.627$, $P = 0.000$), and serving ($T = 5.248$, $P = 0.000$) were significantly higher than those of the control group, indicating that this teaching method effectively enhances mastery of volleyball skills. The combination of pre-class video learning, in-class interactive drills, and

teacher guidance enables students to grasp key techniques more efficiently. In contrast, traditional instruction relies primarily on teacher explanations and offers limited opportunities for student-driven exploration and practice. The flipped classroom emphasizes student autonomy and timely feedback, facilitating faster skill acquisition through repeated practice and immediate correction. This aligns with Hattie's [11] theory of "Visible Learning through Feedback and Collaboration," as the BOPPPS model's summary and feedback components help guide targeted training, thereby enhancing learning outcomes. The significantly greater improvement in the experimental group further confirms that the flipped classroom model accelerates skill acquisition, in line with teaching philosophies that emphasize interaction, practice, and feedback. Therefore, this teaching method can be promoted in physical education to improve students' technical proficiency.

4.3 The Impact of the BOPPPS Model Combined with Flipped Classroom Teaching on Psychological Empowerment

The experimental group performed significantly better than the control group in terms of situational motivation in sports, autonomous learning ability in physical education, and interest in learning ($P<0.05$), indicating that this teaching approach can effectively enhance students' psychological empowerment. The BOPPPS model, by clarifying learning objectives and incorporating staged assessments, helps students perceive their own progress and improves their sense of self-efficacy [12].

In terms of situational motivation in sports, the experimental group scored significantly higher (3.68±0.32) than the control group (3.41±0.38, P=0.001), indicating that the flipped classroom approach enhances students' intrinsic motivation and encourages more active participation in physical education. Emphasizing self-exploration, classroom interaction, and feedback, this method enables students to experience a sense of achievement in sports, thereby increasing their willingness to participate.

Regarding autonomous learning ability in physical education, the experimental group scored higher (3.77±0.43) than the control group (3.52±0.52, P=0.017), suggesting that this teaching method effectively cultivates independent learning. The flipped classroom requires pre-class self-study and reinforces understanding through in-class interaction, helping students develop good study habits and strengthen self-management. In contrast, traditional teaching mainly involves passive knowledge reception, offering limited opportunities for developing autonomous learning skills.

In terms of interest in learning physical education, the experimental group scored higher (3.78±0.42) than the control group (3.52±0.65, P=0.036), indicating that the flipped classroom enhances students' interest in learning. Its diverse teaching design emphasizes interaction, task-driven activities, and hands-on practice, creating a relaxed learning environment that boosts student enthusiasm and initiative. In comparison, traditional teaching methods are relatively monotonous, often leading to boredom. Therefore, this teaching method is worth promoting to enhance students' interest in physical education.

5. Conclusion

The BOPPPS model combined with the flipped classroom teaching method demonstrates significant advantages in improving college students' mastery of volleyball skills and psychological empowerment. Compared with traditional teaching, this approach effectively enhances autonomous learning ability, learning interest, and situational motivation in sports, and can improve skill acquisition in a relatively short period. First, educators should focus on stimulating students' learning motivation by creating positive learning environments and providing diverse learning resources to enhance intrinsic motivation. Second, autonomous learning skills should be strengthened through the flipped classroom model, which creates a closed-loop learning process—pre-class preparation, in-class interaction, and post-class review—thereby improving learning outcomes. Lastly, interactive teaching methods such as group collaboration and task-based learning should be adopted to increase students' engagement

and interest in physical education. Therefore, the BOPPPS model integrated with the flipped classroom teaching method is worth promoting to optimize instructional models and improve teaching quality. Future reforms in physical education should further integrate information technology, interactive teaching, and practical training to more effectively enhance students' athletic performance and overall competence.

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