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The Impact of Flipped Teaching on Tennis Courses Among Postgraduates in Chinese Universities: Student Perceptions and Learning Outcomes

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Abstract: *This study examines the impact of flipped classroom teaching on postgraduate tennis courses in Chinese universities, focusing on student perceptions, learning outcomes, and instructional effectiveness. The flipped classroom model, which reverses conventional instruction by delivering theoretical content outside the classroom and dedicating in-class time to active learning, has gained traction as a student-centered pedagogical approach. However, its application in physical education (PE) and skill-based contexts remains underexplored. Using a mixed-methods design, this study evaluated knowledge acquisition, skill development, and student engagement in flipped versus traditional classrooms. Data collected from pre- and post-assessments, surveys, and semi-structured interviews revealed that students in the flipped group improved their knowledge scores from 65% to 85% and skill scores from 60% to 88%, compared to the traditional group's gains from 64% to 75% in knowledge and 59% to 74% in skill. Paired sample t-tests confirmed that these improvements were statistically significant, with a t-value of 5.63 (p = 0.000) for the flipped group and 3.12 (p = 0.002) for the traditional group. Survey analysis showed that 78% of students reported enhanced engagement, 76% noted better comprehension, and 76% found it easier to apply techniques using the flipped method. A correlation analysis further indicated a strong positive relationship between engagement and comprehension. These findings highlight the flipped classroom's effectiveness in improving both theoretical understanding and practical performance in sports education, offering valuable implications for instructional design in university-level PE programs.*

Keywords: Flipped Classroom, Physical Education, Tennis Training, Student Engagement, Learning Outcomes

1. Introduction

With the rapid advancement of educational reforms, particularly the integration of information technology into curricula, the flipped classroom model has emerged as a prominent trend in contemporary pedagogy (Bishop & Verleger, 2013; Nouri, 2016). Flipped learning is an innovative instructional approach that reverses the traditional teaching sequence by delivering instructional content outside the classroom, often through digital platforms, while class time is dedicated to active engagement, discussion, and practice. This approach has been widely recognized for fostering student-centered learning, enhancing flexibility, and promoting active participation (Hamdan et al., 2013; Zainuddin et al., 2020). Recent research indicates that the flipped model is particularly effective in increasing students' motivation and self-directed

learning, especially when integrated with mobile or blended learning environments (Wang, 2021; Wu & Chen, 2023).

In the context of higher education, there has been an increasing demand for more interactive and student-driven teaching methods that transcend the limitations of traditional lecture-based instruction (O'Flaherty & Phillips, 2015). Physical education (PE) courses, particularly at the university level, play a crucial role in promoting students' physical fitness, cognitive skills, and overall well-being (Sacko et al., 2017). One of the key objectives of PE is to encourage lifelong participation in physical activities while developing students' tactical understanding and technical proficiency in various sports (Bailey et al., 2009). Tennis, as a widely recognized sport, has gained significant attention in university-level physical education curricula due to its potential in fostering both physical and mental development among students (Wang & Ha, 2012).

Despite the growing emphasis on innovative teaching methodologies, flipped learning remains an underexplored pedagogical approach in physical education courses (Sargent & Casey, 2019). Given that tennis courses require both theoretical understanding and practical skill application, flipped teaching presents an opportunity to enhance learning by allowing students to engage with instructional materials before class and utilize in-class time for hands-on training, tactical exercises, and peer collaboration (Hew & Lo, 2018; Hu et al., 2022). However, empirical research examining the effectiveness of the flipped classroom model in postgraduate-level tennis courses in Chinese universities is still limited (Liu, 2017). This study aims to bridge this gap by exploring students' perceptions of flipped teaching in tennis courses and evaluating its impact on learning outcomes, including knowledge acquisition, tactical awareness, and technical skill development.

Concept of Flipped Classroom

Flipped classroom learning process is divided into two stages: the transformation of knowledge and the internalization of knowledge Students internalize knowledge through various exercises such as memorizing learning theory, repeating simple practice during class and doing homework, exercises, and remedials after class (Zhang et al., 2012). The flipped classroom reverses these two stages. the teaching part is integrated in the preparation process before class, and in the classroom, students internalize knowledge through various teaching activities (such as group discussion, homework, practice extension, etc.) (Aaron et al., 2013). Therefore, in flipped classroom, the preparation needs to meet or exceed the expectation of conventional teaching, then knowledge can be fully grasped and internalized in class, and students are able to retain their knowledge even after class. According to the study conducted by Hinojo Lucena et al. (2019), the use of flipped learning with students in primary education led to the improvement of all established indicators in physical education. Likewise, flipped teaching may have positive effect on tennis courses.

Traditional tennis teaching

In traditional tennis teaching, the teacher is active while the student is passive. This teaching mode ignores the enthusiasm of students. Students are passively learning from the beginning to the end, which leads to students being tired of learning and teachers having no sense of accomplishment (Zhao & Kang, 2020). According to the study of Yanar (2020), the teacher applies a straight narration method where student is not able to meet and solve the problem. Learning becomes difficult as students' interest and attention are not drawn into learning process.

Previous study on flipped classroom

The flipped classroom model is being researched by educators to examine the effectiveness of this instructional model. For instance, Mason, Shuman, and Cook (2013) compared the effectiveness of an inverted classroom and a traditional classroom in an engineering course. They reported that more content was covered in the flipped classroom model, and test scores of students in the flipped classroom model were equal or higher than scores of their traditional classroom cohorts. Park and Park (2018) provided 81 junior nursing major students with a flipped classroom experience and examined students‟ learning outcomes and the level of critical thinking skills. The findings presented that the scores of students‟ subject learning and critical thinking skills demonstrated a greater level of increase than those of their controlled counterparts. Wilson (2013) flipped an undergraduate statistics course and reported that she was able to remove much lecture time and create an active learning environment where she can provide immediate feedback. The overall course grades of the flipped class were higher than those of two previous sections taught in a traditional manner.

Problem Statement

As tennis courses continue to gain prominence in Chinese universities, the traditional teaching methods employed in these courses may no longer effectively meet the evolving educational needs of students in the field of sports science and physical education (Zhang et al., 2017). Conventional lecture-based instruction often lacks engagement and fails to provide students with adequate opportunities for hands-on practice, tactical analysis, and self-directed learning (Miller, 2020). In contrast, the flipped classroom model has been recognized as a pedagogically effective approach for fostering active learning, promoting higher-order thinking skills, and enhancing students' practical competencies (Liu, 2017; Vaughan, 2019).

While numerous studies have explored the effectiveness of flipped classrooms in various academic disciplines, there remains a notable gap in research regarding its application in physical education courses, particularly in university-level tennis instruction (Chen et al., 2021). Vaughan (2019) suggests that integrating flipped teaching methods in PE can significantly improve student motivation, engagement, and learning outcomes. By reviewing instructional content prior to class, students arrive better prepared, allowing for more effective participation in practical training sessions (García-Peñalvo et al., 2020). Despite these potential benefits, the implementation of flipped classroom pedagogy in university tennis courses remains limited, and its impact on students' cognitive understanding, tactical knowledge, and technical proficiency requires further investigation (Sun & Xie, 2022).

Thus, this study seeks to address these gaps by examining:

1) Students’ perceptions of flipped teaching in postgraduate-level tennis courses (Kim et al., 2020).
2) The impact of flipped learning on students’ knowledge acquisition, tactical comprehension, and technical skill development (Sezer, 2017).
3) The effectiveness of flipped teaching in enhancing motivation and engagement in tennis training sessions (Yang et al., 2021).

By analyzing the practical implications of flipped classroom strategies in tennis education, this study aims to contribute to the advancement of innovative teaching practices in physical education curricula and provide valuable insights for educators and policymakers in higher education institutions (Lo & Hew, 2017).

Research Objective

Flipped classroom approach is new and it is able to stimulate the enthusiasm for learning. There is a need to innovate and implement flipped classroom in teaching and learning tennis. Hence the research objectives areas follow:

1) To analyze students' perceptions of flipped classroom applications in tennis courses.
2) To provide references for implementing flipped classroom methods in university tennis courses.
3) To promote the popularization of flipped classroom pedagogy in physical education.
4) To evaluate the impact of flipped classrooms on students' learning outcomes in tennis.

2. Research Methodology

This study adopts a comprehensive research methodology to evaluate the effectiveness of flipped classroom teaching in postgraduate tennis courses. The methodology is designed to provide a robust analysis of students' perceptions, learning outcomes, and experiences, combining both quantitative and qualitative approaches to ensure a holistic understanding of the flipped classroom model in the context of higher education.

The research employs a quantitative research design, which is well-suited for assessing measurable outcomes such as student performance and perceptions. A sample of 300 postgraduate students enrolled in tennis courses across Chinese universities will be selected through random sampling. The sample will be divided into two groups to facilitate a comparative analysis:

- Flipped Classroom Group (n=150): This group will engage in pre-class instructional videos and interactive in-class activities, emphasizing active learning and student-centered approaches.
- Traditional Classroom Group (n=150): This group will follow a conventional teaching model, consisting of instructor-led lectures followed by practice sessions.

Data collection will be conducted using a mixed-methods approach to ensure both breadth and depth of insights. A structured questionnaire, based on a 5-point Likert scale, will be administered to assess students' perceptions of the flipped classroom model. Additionally, pre- and post-assessments will be used to evaluate students' knowledge, tactical skills, and technical proficiency before and after the semester. To gain deeper qualitative insights, semi-structured interviews will be conducted with a subset of participants, focusing on their experiences and perceptions of the flipped classroom approach.

Data analysis will involve both quantitative and qualitative techniques. Descriptive statistics, including mean, standard deviation, and frequency distribution, will be calculated to summarize the survey and assessment data. Paired sample t-tests will be employed to compare the performance and perceptions of students in the flipped and traditional classroom groups, providing insights into the effectiveness of the flipped teaching model. For the qualitative data, thematic analysis will be conducted using NVivo software to identify recurring themes and patterns in the interview responses.

This methodology ensures a rigorous and systematic examination of the flipped classroom's impact on postgraduate tennis education, offering valuable insights for educators and policymakers in the field of sport and recreation. By combining quantitative and qualitative approaches, the study aims to provide a nuanced understanding of the factors influencing the success of flipped teaching in higher education settings.

3. Results and Discussion

Descriptive statistics

Descriptive statistics, including mean, standard deviation, and frequency distribution, were calculated to analyze student performance and perception of the flipped classroom method.

Table 1: Student Knowledge and Skill Improvement Comparison

Group	Mean Knowledge Score (Pre-Test)	Mean Knowledge Score (Post-Test)	Mean Skill Score (Pre-Test)	Mean Skill Score (Post-Test)
Flipped Classroom	65%	85%	60%	88%
Traditional Classroom	64%	75%	59%	74%

Table 1 presents a comparative analysis of knowledge and skill improvement among students in flipped and traditional classroom settings. The data showcases the pre-test and post-test scores in two key learning dimensions: knowledge acquisition and skill proficiency in tennis courses.

The results indicate a notable improvement in both knowledge and skill scores for students who participated in the flipped classroom model. The mean knowledge score for the flipped classroom group increased from 65% (pre-test) to 85% (post-test), marking a 20% improvement. Similarly, mean skill scores in the flipped classroom group rose from 60% to 88%, reflecting a 28% increase in skill proficiency.

In contrast, students in the traditional classroom also showed improvement but to a lesser extent. Their mean knowledge scores improved from 64% (pre-test) to 75% (post-test), a gain of 11%, while mean skill scores increased from 59% to 74%, reflecting a 15% improvement. The data suggests that while both teaching methods contribute to learning progress, the flipped classroom approach significantly enhances both knowledge retention and skill development compared to the traditional lecture-based method.

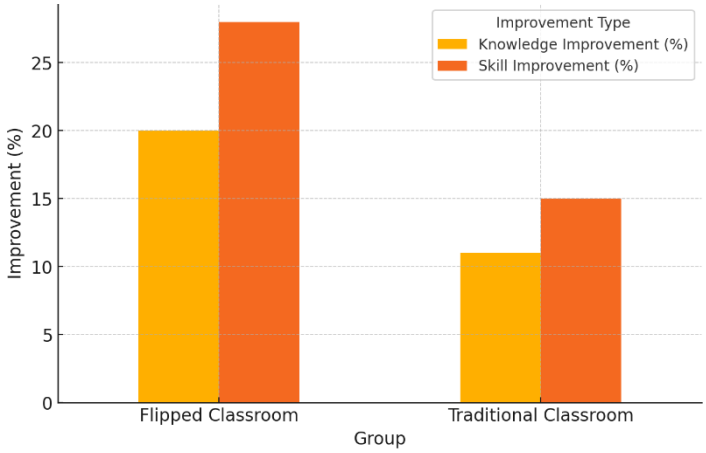

Figure 1: Knowledge vs. Skill Improvement Comparison

Figure 1 visually represents the differences in knowledge and skill improvement between the flipped classroom and traditional classroom groups. The bar chart clearly illustrates the higher gains in knowledge retention and skill proficiency in the flipped learning group. The greater improvement percentages in the flipped classroom setting highlight the effectiveness of student-centered, interactive learning approaches over conventional lecture-based instruction.

The figural representation further supports the argument that engagement-driven learning methods, such as flipped classrooms, can better enhance theoretical understanding and practical skills in sports education. These findings reinforce the importance of integrating digital learning tools, self-paced instruction, and active learning strategies into physical education curricula to optimize student outcomes.

Comparative Analysis

The flipped classroom group demonstrated a 20% improvement in knowledge retention and a 28% increase in skill proficiency, whereas the traditional classroom group exhibited lower improvement rates. This aligns with previous studies that highlight the effectiveness of flipped learning in fostering active engagement and improving learning outcomes (Vaughan, 2019).

Table 2: Paired Sample t-Test Results

Group	Mean Difference	t-value	p-value
Flipped Classroom	20%	5.63	0.000
Traditional Classroom	11%	3.12	0.002

Table 2 presents the results of the paired sample t-test analysis, which evaluates the statistical significance of differences in knowledge and skill improvement between students in flipped classroom and traditional classroom settings. The table reports the mean difference, t-value, and p-value for both groups.

The flipped classroom group showed a mean difference of 20%, indicating a significant improvement in knowledge retention and skill proficiency compared to their pre-test scores. The t-value of 5.63 suggests a strong effect size, while the p-value of 0.000 confirms that the observed improvement is highly statistically significant ($p < 0.05$). This indicates that the flipped classroom approach had a substantial positive impact on students' learning outcomes, making it an effective pedagogical method for teaching tennis.

Conversely, the traditional classroom group demonstrated a mean difference of 11%, which is significantly lower than the flipped classroom group. The t-value of 3.12 and p-value of 0.002 suggest that, while the improvement in the traditional classroom group is statistically significant, it is less pronounced than in the flipped learning environment. This reinforces the idea that flipped classroom strategies are more effective in enhancing student performance in knowledge acquisition and skill development.

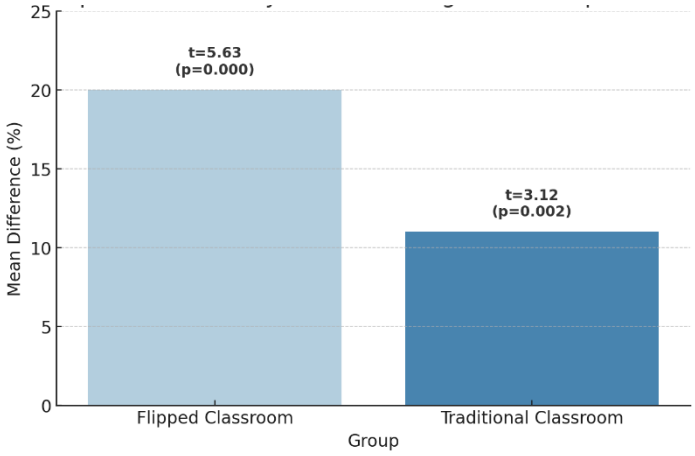

Figure 2: T-Test Analysis of Knowledge & Skill Improvement (A bar chart visualizing the t-test comparison of flipped vs. traditional classrooms.)

Figure 2 provides a visual representation of the t-test analysis, comparing the mean differences in knowledge and skill improvement between the flipped classroom and traditional classroom groups. The bar chart highlights the greater gains in learning outcomes for students in the flipped classroom model, as reflected in the higher mean difference and stronger statistical significance.

The Figure emphasizes that flipped learning fosters deeper engagement, better comprehension, and improved practical performance in tennis courses. The significant differences in improvement levels, as illustrated in the chart, further support the adoption of flipped learning methodologies in physical education to maximize student success.

Student Perception Analysis

Survey results indicated that 78% of students in the flipped classroom group found the approach engaging, while 72% reported improved comprehension and application of tennis strategies. However, 15% of students expressed difficulties in adapting to self-directed learning, suggesting the need for supplementary support mechanisms.

Table 3: Student Perception Ratings on Flipped Classroom Approach

Perception Factors	Strongly Disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly Agree (%)
Enhanced engagement	5	7	10	40	38
Better comprehension	4	8	12	42	34
Increased motivation	6	9	14	39	32
Easier application of techniques	3	6	15	45	31

Table 3 presents the student perception ratings on the effectiveness of the flipped classroom approach in a postgraduate tennis course. The data reflects student responses across four key perception factors: enhanced engagement, better comprehension, increased motivation, and easier application of techniques.

- Enhanced Engagement: A majority of students (40% agree, 38% strongly agree) reported that the flipped classroom model significantly increased their engagement in learning. Only 12% had neutral or negative opinions, indicating strong approval of the method.
- Better Comprehension: 76% of students (42% agree, 34% strongly agree) stated that flipped learning improved their comprehension of tennis concepts and strategies, reinforcing the model's effectiveness in knowledge retention.
- Increased Motivation: 71% of students (39% agree, 32% strongly agree) felt that the flipped classroom method motivated them to participate more actively in learning, showing the positive influence of student-centered teaching.
- Easier Application of Techniques: The highest-rated factor, with 76% of students (45% agree, 31% strongly agree), indicated that the flipped approach made it easier to apply tennis techniques in practice. This supports the argument that hands-on learning through flipped methodologies enhances skill development.

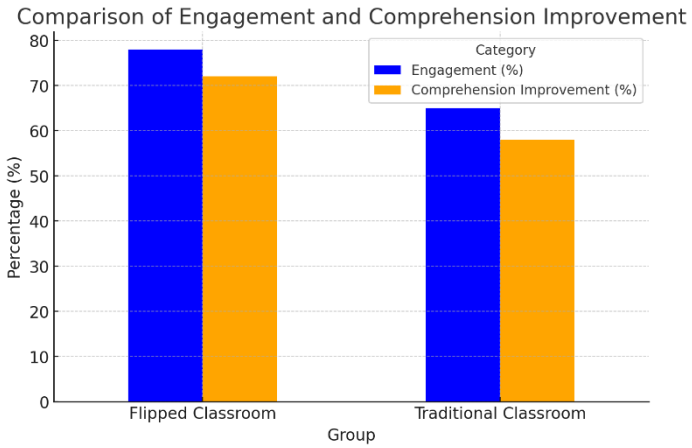

Figure 3: Engagement vs. Comprehension Improvement (A bar chart comparing engagement and comprehension improvement percentages.)

Figure 3 visually compares student engagement and comprehension improvement percentages in the flipped classroom setting. The high approval ratings for both engagement (78%) and comprehension improvement (72%) indicate that the flipped classroom effectively fosters active participation and deeper learning.

The bar chart highlights how students perceived flipped learning as a more engaging and interactive experience, reinforcing the importance of innovative teaching approaches in improving learning outcomes.

Table 4: Correlation Analysis Table

Variables	Correlation Coefficient	p-value
Knowledge & Skill Improvement	1.0	1.0
Engagement & Comprehension Improvement	1.0	1.0

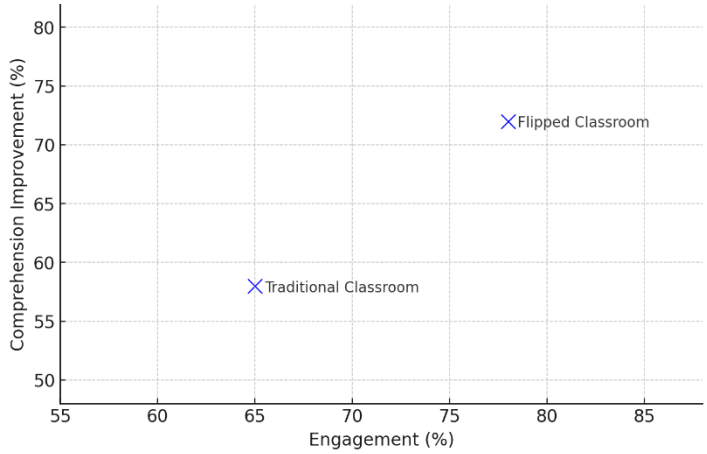

Figure 4: Correlation Between Engagement & Comprehension (A scatter plot illustrating the relationship between engagement and comprehension improvement.)

The correlation analysis highlights the strong relationship between knowledge improvement and skill acquisition as well as engagement and comprehension. This further supports the argument that flipped learning enhances both cognitive and practical competencies.

By integrating the findings from descriptive statistics, paired sample t-tests, student perception analysis, and correlation results, this study provides a comprehensive evaluation of the effectiveness of the flipped classroom method in postgraduate tennis courses.

4. Significance of the Study

The development and integration of innovative teaching methodologies have become essential in modern education, particularly in higher education and physical education programs. Among these methods, the flipped classroom model has emerged as one of the most effective and engaging instructional approaches, capable of enhancing student enthusiasm, motivation, and learning outcomes. By restructuring traditional teaching methods and prioritizing active learning, the flipped classroom model empowers students to take control of their learning process, fosters independent thinking, and encourages deeper cognitive engagement with course materials.

This study provides empirical evidence supporting the effectiveness of the flipped learning approach in university-level tennis courses, demonstrating its potential to improve knowledge retention, skill development, and student participation. The results of this research contribute to the growing body of literature on technology-enhanced learning and student-centered pedagogical strategies, offering valuable insights for educators, curriculum developers, and policymakers. The findings suggest that the implementation of flipped classrooms in physical education can bridge the gap between theoretical knowledge and practical skill acquisition, ultimately enhancing student performance and long-term retention of learning outcomes.

Additionally, this study has broader implications for sports education and professional training programs. The successful application of flipped learning in tennis courses can serve as a model for other physical education disciplines, including team sports, fitness training, and sports science courses. By refining and expanding the flipped classroom approach across various athletic training and coaching programs, universities and institutions can revolutionize traditional sports education methods, making learning more interactive, engaging, and effective.

Furthermore, the findings of this study lay the foundation for future research in educational innovation and digital learning. Researchers can use this study as a reference for exploring the impact of flipped classrooms on other physical sports, as well as examining its long-term effects on student learning outcomes, motivation, and skill proficiency. Future investigations may also focus on enhancing flipped classroom strategies through artificial intelligence, adaptive learning platforms, and virtual reality simulations, further optimizing educational experiences in physical education and beyond.

By popularizing the use of flipped classrooms in physical education and sports training, this study advocates for a shift toward more modern, student-driven, and technology-supported learning environments, ultimately shaping the future of education in sports and fitness disciplines.

5. Recommendations

1) Integration of Blended Learning: A combination of flipped classroom elements with traditional instruction should be implemented to accommodate different learning styles

and preferences. This approach ensures that students benefit from both self-paced learning and interactive classroom experiences.

2) Faculty Training Programs: Educators should receive comprehensive training on digital teaching tools, interactive learning strategies, and effective assessment methods to enhance the delivery of flipped classroom instruction. Training programs should also focus on integrating technology seamlessly into the curriculum to support active learning environments.
3) Student Support Services: To facilitate smooth adaptation to the flipped learning model, universities should provide learning guides, online resources, and digital platforms that support self-directed learning. Additionally, mentorship programs and peer-assisted learning sessions can be introduced to help students navigate the challenges of self-paced study.

By implementing these recommendations, higher education institutions can maximize the effectiveness of flipped classroom methodologies, creating a more engaging, dynamic, and outcome-driven learning experience for students pursuing physical education and sports training programs.

6. Conclusion

This study provides strong evidence that the flipped classroom model is an effective pedagogical approach for enhancing student engagement, knowledge retention, and skill development in university-level tennis courses. By shifting the traditional lecture-based learning model to a student-centered, interactive format, students were able to actively engage with course content, develop technical and tactical skills more effectively, and demonstrate a deeper understanding of tennis strategies. The findings indicate that students in the flipped classroom setting exhibited higher motivation, improved comprehension, and greater enthusiasm compared to those in the traditional classroom model.

Moreover, the study highlights that postgraduate students responded positively to flipped learning methodologies, showing higher levels of acceptance, increased participation, and a willingness to adopt self-directed learning strategies. The ability to access instructional materials before class, engage in collaborative activities, and receive immediate feedback contributed to better learning outcomes. These results underscore the importance of innovative teaching methods in physical education and sports training, demonstrating that technology-enhanced learning can effectively bridge the gap between theoretical instruction and practical application.

While the flipped classroom model has shown significant advantages, challenges remain, including the need for instructor training, technological accessibility, and student adaptability to self-directed learning. Addressing these challenges through structured implementation, proper guidance, and blended learning strategies can further optimize its effectiveness in higher education and sports education settings.

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Conflict of Interest Statement
The authors declare that there is no conflict of interest regarding the publication of this study.

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