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ORIGINAL

On the improvement of volleyball specialty performance of Chinese Higher Vocational College students through application-based learning methodology

Sobre la mejora del rendimiento de la especialidad de voleibol de los estudiantes chinos de la Universidad Vocacional Superior a través de la metodología de aprendizaje basada en la aplicación

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ABSTRACT

This study aims to improve the volleyball specialty performance of Chinese higher vocational college students through the application of problem-based learning methodology. Using a quasi-experimental design, with 81 students from a vocational college in Zhejiang Province, China, including 41 students in the experimental group and 40 students in the control group. The experimental group received interventions using problem-based learning methodology for 12 weeks, while the control group received traditional classroom teaching during the same period. Additionally, this study applied pre-test and post-test measurements on volleyball specialty performance, including bumping, serving, practical skills, and overall scores, and conducted data analysis using statistical methods. The results showed significant differences between the pre-test and post-test scores of both the experimental and control groups, with the post-test scores higher than the pre-test scores, indicating better performance in the experimental group compared to the control group.

Keywords: Problem-Based Learning; Chinese Higher Vocational College Students; Volleyball Specialty Performance.

RESUMEN

Este estudio tiene como objetivo mejorar el rendimiento de la especialidad de voleibol de los estudiantes universitarios de formación profesional superior chinos mediante la aplicación de la metodología de aprendizaje basado en problemas. Utilizando un diseño cuasi-experimental, con 81 estudiantes de una escuela vocacional en la provincia de Zhejiang, China, incluyendo 41 estudiantes en el grupo experimental y 40 estudiantes en el grupo control. El grupo experimental recibió intervenciones utilizando la metodología de aprendizaje basado en problemas durante 12 semanas, Además, este estudio aplicó mediciones previas y posteriores a la prueba sobre el rendimiento de la especialidad de voleibol, incluidos los golpes, el servicio, las habilidades prácticas y los puntajes generales, y realizó un análisis de datos utilizando métodos estadísticos. Los resultados mostraron diferencias significativas entre las puntuaciones pre-test y post-test tanto del grupo experimental como del grupo control, siendo las puntuaciones post-test superiores a las puntuaciones pre-test, lo que indica un mejor rendimiento en el grupo experimental en comparación con el control grupo.

Palabras clave: Aprendizaje Basado en Problemas; Estudiantes Universitarias de Formación Profesional Superior Chinos; Rendimiento de la Especialidad de Voleibol.

INTRODUCTION

Physical education is not only a source of knowledge but also plays a crucial role in improving athletic skills, health levels, academic achievements, or educational values (Corbin et al., 2020). Researchers have emphasized that physical education not only enhances physical fitness and motor skills but also promotes positive health behaviors through sports activities (Mao & Li, 2019), fostering communication, cooperation, respect, innovation, and social responsibility among students (Brinkley et al., 2017; Wang et al., 2021). By promoting physical and mental health development, sports enable students to become high-quality workers who can meet societal demands (Yang, 2017). Therefore, physical education is included in the compulsory curriculum of Chinese higher vocational education, aiming to improve students' physical and mental health, enhance physical fitness, develop comprehensive vocational abilities, cultivate lifelong physical exercise awareness, abilities, and habits.

Volleyball is one of the main teaching contents in physical education in Chinese higher vocational colleges (Wang & Dong, 2021). As a team sport, volleyball plays an important role in promoting physical and mental health, enhancing social interactions, and improving social adaptability (Chen, 2020). In volleyball matches, each team consists of six players separated by a high net, scoring points by landing the ball on the opponent's court without violating rules (Chacoma & Billoni, 2022). The complexity of volleyball matches means that if one player fails to control the ball, the team loses the scoring opportunity, making accurate passing crucial for teammates' ball control. Additionally, if a player fails to attack or serve accurately, it increases the probability of the opponent scoring directly (Dincer, 2015). Therefore, mastering solid volleyball techniques is essential for beginners and low-level practitioners to learn (Chen, 2017), and good technical and tactical abilities are crucial for scoring in volleyball matches (Silva et al., 2014). Furthermore, acquiring a sports skill serves as a driving force for individuals to engage in physical exercise continuously, promoting positive health behaviors (Qiang et al., 2016; Trajković et al., 2020).

However, the implementation results of volleyball courses in Chinese higher vocational colleges are worrying. Chen and Lin (2020) found through surveys that students' performance in completing volleyball techniques and tactics is unsatisfactory, with most students only mastering simple bumping and serving techniques and lacking skills in passing, spiking, blocking, and practical abilities for participating in volleyball matches. Yuan (2019) reported that although 80 % of higher vocational colleges in Tianjin, China offer volleyball courses, the teaching content only involves self-bumping and serving, with no competitive exercises or teaching matches, leading to only a few students showing interest in volleyball at the end of the semester. Traditional teaching methods suffer from outdated content, single teaching methods, uneven student levels, insufficient class hours, and weak links in sports knowledge learning (Dai et al., 2017; Liu et al., 2019; Wei, 2018), resulting in insufficient understanding of knowledge and inadequate recognition of the value of physical education among students (Aji & Fahmi, 2020).

Higher education should provide diversified teaching methods to cultivate the experiential value of courses (Lupo et al., 2015). Physical education learning requires certain physical foundations and technical conditions. Only by using student-centered learning methods can students improve their understanding of physical education through the process of free thinking, thus cultivating their thinking ability and learning attitude towards physical education (Fadlan & Anshor, 2022). Empirical studies have shown that shifting the teaching subject from teachers to students, changing the teaching focus from memorizing facts to discovering knowledge, diversifying teaching practices, and transforming the teacher's role from a classroom dominator to a guide are important strategies to improve the quality of physical education (Widjayana et al., 2022). Empowering learners with more autonomy in the learning process allows students to find goals in self-purpose and decision-making (Munafo, 2016). Physical education learning is an active cognitive process (Backes et al., 2023), and teachers should demonstrate professional competence in curriculum design, fully utilize various teaching resources and strategies, stimulate and generate autonomous learning activities (Kitsantas et al., 2018), ensure student engagement and learning investment, to achieve the goals of physical education learning (Luo et al., 2020).

Problem-based learning (PBL) is a method that can improve cognition, emotion, and awareness. It is a learning approach that designs learning materials in the form of problems based on relevant background environments, encouraging students to acquire knowledge and understand concepts; through processes such as discussion and reflection, it achieves autonomous learning ability (Dastgeer & Afzal, 2015); it is a learning method in which learners participate in group practices to acquire skills or solve skill problems (Aslan, 2021). The learner-centered model of PBL emphasizes the construction of knowledge, skills, and the meaning of learning through learners' self-directed processes of solving problems in practice (Jang, 2023). Wang (2017) proposed a student-centered PBL model, which provides opportunities for students to discover and solve problems using critical thinking individually or in groups, encouraging students to be more active in the learning process, promoting deep learning to enhance students' athletic levels. Setiawan (2017) believed that in PBL physical education teaching, student group cooperation, self-motivation, and other methods help students improve their intrinsic

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potential and achieve better exam results. Prasetyo et al. (2022) found that with the implementation of PBL learning models, students' performance in asking questions, answering questions, discussing, and implementing volleyball exercises improved, increasing students' participation in volleyball learning activities to improve volleyball skills. Salatenko & Dubinskaya (2015) conducted empirical surveys on volleyball popularization training and found that applying the PBL model has a positive impact on sports skills and health knowledge.

In summary, the unsatisfactory results of volleyball learning are a significant issue in Chinese higher vocational physical education teaching. Therefore, this study applies problem-based learning to volleyball teaching to improve the volleyball specialty performance of Chinese higher vocational college students.

METHOD

Participants

Convenience cluster sampling was employed to select students from a vocational college in Zhejiang Province, China, who were enrolled in the first year of the volleyball elective class. A total of 81 students participated in the study, including 34 male students. Theoretically, the learning and athletic levels of the two classes were equivalent. One class consisted of 41 students (16 males, 25 females) who were designated as the Experimental Class (EC) and received interventions based on problem-based learning methodology. The other class comprised 40 students (18 males, 22 females) who served as the Control Class (CC) and received instruction through traditional teaching methods.

Participants Research Intervention

This study aimed to provide vocational college students in China with volleyball skills training using problem-based learning methodology. The Experimental Class received instruction in basic volleyball techniques and match practical skills using problem-based learning methodology for a total of 24 lessons, with each lesson lasting 45 minutes, over a period of 12 weeks. The teaching approach for the Experimental Class incorporated the principles and characteristics of problem-based learning, integrating knowledge, skills, and abilities into the content organization. The teaching process emphasized the implementation of problem-based learning teaching steps such as discussion, practice, and reflection. The teaching organization primarily adopted a group format for problem-based learning, dividing the class into three stages: preliminary preparation, cooperative exploration, and evaluation and summary. The Control Class received instruction through traditional teaching methods, which consisted of warm-up exercises focusing on jogging and dynamic stretching in the beginning, followed by explanations, demonstrations, student practice, teacher guidance, or teaching matches for the basic part, and concluded with relaxation and summary. In traditional teaching classes, teachers delivered lectures to the entire class rather than individual groups, and the teaching time and content were the same as those of the experimental group but did not follow the problem-based learning process. The specific teaching design for problem-based learning in the Experimental Class is outlined in table 1.

Table 1. Contrast Table of Course Teaching Design Differences between Experimental and Control Classes

Item	Experimental Class	Control Class
Teaching Objectives	Cultivate teamwork skills Enhance volleyball skills	Cultivate teamwork skills Enhance volleyball skills
Teaching Content	Vocational Physical Education and Health	Vocational Physical Education and Health
Teaching Methods	Problem-based learning methodology including independent learning, group learning, problem discussion, situational practice, presentation demonstration, evaluation feedback, etc.	Mainly traditional teaching methods including explanation demonstration, imitation practice, collective correction, independent practice, etc.
Teaching Environment	Teaching based on the Cloud Classroom platform	Teaching based on the Cloud Classroom platform
Teacher's Role	Facilitator and guide of teaching	Main lecturer of teaching
Student's Role	Autonomous learners, group collaborators, self-evaluators and peer evaluators, emphasizing student-centeredness	Primarily listening and skill practice
Teaching Staff	Same teaching staff, not the researcher herself	Same teaching staff, not the researcher herself
Duration of Teaching	12 weeks, a total of 24 class hours	12 weeks, a total of 24 class hours

Note: Compiled by the study

Research Tools

The same measurement tools were used for pre-test and post-test assessments of volleyball specialty scores for both the experimental and control classes. Assessments were completed during class time and no separate standardized testing time was arranged. Liu Wenhao (2000) proposed a method of assessment and

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scoring criteria for volleyball elective courses in ordinary colleges and universities, which underwent expert reliability and validity testing. It was found that the assessment of volleyball skills in ordinary colleges and universities should include four parts: passing, digging, serving, and spiking, with a reliability test consistency of 0,81-0,88. Dai Ke et al. (2007) suggested that the assessment of volleyball skills for college freshmen should reflect a horizontal evaluation of techniques and tactics from easy to difficult. They proposed preliminary and intermediate technical standards for digging, passing, and serving, aiming to better stimulate students' learning enthusiasm and lay a solid foundation for sustainable learning. Gu Shaoxiong (2008) proposed incorporating practical playing ability assessments into the evaluation system of volleyball elective courses for college students, suggesting that the success rate of five technical skills including passing, digging, serving, spiking, and blocking, as well as the level of teamwork cooperation, be used as evaluation indicators for practical playing ability. Huang Jiaqi (2017) conducted a survey on the evaluation content of sports skills in volleyball elective courses for college students in China and found that over 90 % of colleges and universities included passing, digging, and serving in their volleyball skills assessment, with 52 % of surveyed institutions incorporating practical playing ability into the assessment. Therefore, based on the viewpoints of researchers and in conjunction with the course standards of "Physical Education and Health" implemented by the teaching experiment school, this study designed the measurement of volleyball skills for vocational college students in China to include three dimensions: passing and digging, serving, and practical playing ability. Several experts with relevant but not entirely similar professional knowledge and research backgrounds were invited to conduct validity surveys, yielding an ICC intra-group correlation coefficient of ,893.

Passing and Digging

The passing and digging test assesses the mastery and stability of the candidate's passing and digging skills. Candidates are required to pass and dig the ball face-to-face from a distance of more than 3 meters apart. One point is awarded for each successful pass and dig, totaling 30 points. Correct passing and digging techniques should be used to ensure that the ball is passed with a certain arc suitable for reception and received with a certain height and arc suitable for spiking.

Serving

The serving test assesses whether the candidate can hit the designated target area on the volleyball court. Testees stand behind the service line and serve ten balls each, attempting to place the ball in the high-scoring area (3 points). Points are awarded based on the specific target area hit, with a score of 0 awarded if the ball lands outside the designated area. Additionally, if the ball lands between two scoring areas, the higher value is awarded. The final score is the total of all ten serves. Male students must use an overhead serve, while female students may use either an overhead serve or an underhand serve from the side.

Practical Playing Ability

Practical playing ability assesses the candidate's ability to apply volleyball techniques and tactics in volleyball matches. During teaching matches, teachers assess students' application of techniques and tactics on the volleyball court. Comprehensive evaluations are made of students' success rate and mistakes in executing actions independently, with a total of 40 points. Scores are rounded to one decimal place at most. Two people, including the subject teacher and the researcher, score each student, and the average of the two scores is taken as the final score for practical playing ability.

Statistical Analysis

This study used descriptive analysis to analyze the basic characteristics of the study subjects, independent samples t-tests to analyze pre-test results of the experimental and control groups to examine the volleyball skill levels of the two groups before the experiment. Subsequently, paired samples t-tests were used to analyze the differences between pre- and post-test measurements within the same group, and covariance analysis was used to examine whether the problem-based learning model had a significant impact on the volleyball specialty scores of vocational college students in China.

RESULTS

Pre-tests and post-tests were conducted on 81 students in the experimental and control groups using passing and digging, serving, practical playing ability, and total scores. The collected data were subjected to statistical analysis. Descriptive analysis results of the research sample are presented in table 2. The experimental group comprised 16 male students and 25 female students, while the control group comprised 18 male students and 22 female students. All students were freshmen, and the majority had prior experience in learning or participating in volleyball, although three students in each group had no prior exposure to volleyball.

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Table 2. Descriptive Statistics of Samples in Experimental and Control Groups

Group	Item	Option	Number	Percentage
Experimental Group	Gender	Male	16	39 %
		Female	25	61 %
	Volleyball Learning Experience	Taken volleyball classes	28	68,3 %
		Participated outside of classes	10	24,4 %
		No prior experience	3	7,3 %
Control Group	Gender	Male	18	45 %
		Female	22	55 %
	Volleyball Learning Experience	Taken volleyball classes	29	72,5 %
		Participated outside of classes	8	20 %
		No prior experience	3	7,5 %

Note: Compiled by the study

Results of Volleyball Specialized Scores

Based on the physical education curriculum standards of the school where the teaching experiment was conducted and combined with the viewpoints of existing studies, after being reviewed by relevant domain experts, the volleyball specialized scores in this study were composed of three parts: passing and setting, serving, and game performance, with a total score of 100 points, among which passing and setting and serving accounted for 30 points each, and game performance accounted for 40 points. The descriptive analysis results of pre- and post-test volleyball specialized scores for the experimental and control groups are shown in Table 3. This indicates that there was no significant difference in pre-test scores between the experimental group (M=49,854, SD=7,754) and the control group (M=50,075, SD=8,754), while there was a significant difference in post-test scores, and the results of the experimental group (M=91,240, SD=5,185) were superior to those of the control group (M=84,250, SD=9,562).

Table 3. Descriptive Analysis of Pre- and Post-Test Volleyball Specialized Scores for Experimental and Control Groups

Dimension	Group	Pre-test	Post-test
		M	SD
Passing and Setting	Experimental Group	16,951	3,057
	Control Group	16,925	4,098
Serving	Experimental Group	14,880	3,242
	Control Group	15,080	4,172
Game Performance	Experimental Group	18,024	3,546
	Control Group	18,075	4,576
Total Score	Experimental Group	49,854	7,754
	Control Group	50,075	8,754

Note: Compiled by the current study

Independent Sample t-test of Pre-test Scores for Experimental and Control Groups

Prior to conducting the teaching experiment, it is a prerequisite to examine whether the students in the experimental and control groups have equal abilities in specialized scores. This study used independent sample t-tests to analyze the pre-test data specifically, as shown in table 4.

Table 4. Independent Sample t-tests for Pre-test Scores between Control and Experimental Groups

Dimension	Group	Mean	Standard Deviation	t-value	p-value
Passing and Setting	Control Group	16,925	4,098	0,033	,974
	Experimental Group	16,951	3,057		
Serving	Control Group	15,080	4,172	0,238	,813
	Experimental Group	14,880	3,242		
Game Performance	Control Group	18,075	4,576	0,056	,956
	Experimental Group	18,024	3,546		
Total Score	Control Group	50,075	8,754	0,121	,904
	Experimental Group	49,854	7,754		

Note: Compiled by the current study

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From table 4, it can be observed that the mean scores (M) of passing and setting, serving, and game performance for the experimental group were in the range of 14,880-18,024, with standard deviations (SD) ranging from 3,057-3,546, while for the control group, the mean scores (M) were in the range of 15,080-18,075, with standard deviations (SD) ranging from 4,098-4,576. The t-values for the three dimensions of volleyball specialized scores and the total score ranged from 0,033 to 0,238, and the p-values ranged from 0,813 to 0,974, all of which were greater than 0,05. There were no statistically significant differences in volleyball specialized scores between the two groups. This indicates that before the intervention of problem-based learning in volleyball classes, there were no significant differences in specialized scores between the experimental and control groups, meeting the requirement of homogeneity of initial abilities before the experiment (Kulik & Kulik, 1982).

Paired Sample t-test of Pre- and Post-Test Scores for Experimental and Control Groups

After the teaching experiment intervention, it is necessary to analyze the intergroup differences in pre- and post-test volleyball specialized scores between the experimental and control groups to determine whether there are significant differences in specialized scores of students in each group after the intervention. This study used paired sample t-tests for analysis, with specific results shown in table 5.

Table 5. Paired Sample t-tests for Pre- and Post-Test Scores within Experimental and Control Groups

Dimension	Group	Test	n	M	SD	t	p
Passing and Setting	Experimental Group	Pre-test	41	16,951	3,057	22,369	,000
		Post-test		27,537	3,210		
	Control Group	Pre-test	40	16,925	4,098	19,367	,000
		Post-test		25,475	3,870		
Serving	Experimental Group	Pre-test	41	14,880	3,242	26,233	,000
		Post-test		28,683	2,850		
	Control Group	Pre-test	40	15,080	4,172	25,941	,000
		Post-test		25,875	4,730		
Game Performance	Experimental Group	Pre-test	41	18,024	3,546	31,489	,000
		Post-test		35,024	2,850		
	Control Group	Pre-test	40	18,075	4,576	24,973	,000
		Post-test		32,900	4,460		
Total Score	Experimental Group	Pre-test	41	49,854	7,754	50,809	,000
		Post-test		91,244	5,185		
	Control Group	Pre-test	40	50,075	8,754	37,560	,000
		Post-test		84,250	9,562		

From table 5, it can be observed that the experimental class had significant improvements in specialized scores, with a pre-test mean (M) of 16,951 for passing and setting, 14,880 for serving, 18,024 for in-game abilities, and 49,293 for the total score. In the post-test, the mean scores (M) increased to 27,537 for passing and setting, 28,683 for serving, 35,024 for in-game abilities, and 91,244 for the total score. The improvements were statistically significant (p=,000<0,05). Similarly, the control class showed significant progress, with pre-test mean scores (M) of 16,925 for passing and setting, 15,080 for serving, 18,075 for in-game abilities, and 49,650 for the total score. After the post-test, the total score mean (M) increased to 84,250. These improvements were also statistically significant (p=,000<0,05). This indicates that after 12 weeks of traditional classroom teaching for the control class and problem-based learning intervention for the experimental class, both groups exhibited significant differences in pre-test and post-test total scores, with higher post-test results compared to pre-test, demonstrating the superiority of the experimental class.

Analysis of Covariance (ANCOVA) between Experimental and Control Groups

To further understand whether there were significant differences in volleyball specialty scores between the experimental and control groups in the post-test, this study employed a one-way Analysis of Covariance (ANCOVA) method. The volleyball specialty scores from the pre-tests of both groups were used as covariates, while the volleyball specialty scores from the post-tests were considered as the dependent variables, with groupings as the fixed factor, for conducting the ANCOVA analysis. Before conducting the one-way ANCOVA analysis, it is essential, according to the assumptions of ANCOVA analysis, to check whether the regression coefficients within

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groups adhere to the homogeneity assumption, to examine whether the independent variable has a significant effect on the dependent variable (Fang et al., 2022). The homogeneity test results of the regression coefficients of volleyball specialty scores are summarized in table 6.

Table 6. Homogeneity Test of Regression Coefficients of Volleyball Specialty Scores between Experimental and Control Groups

Dimension	Source	SS	df	MS	F	p
Passing & Setting	Covariate	426,575	1	426,575	45,666	,000
	Covariate*Group	33,672	1	33,672	4,730	,033
	Error	56,381	77	56,381		
Serving	Covariate	540,532	1	540,532	60,767	,000
	Covariate*Group	97,817	1	97,817	13,934	,000
	Error	161,485	77	161,485		
In-game Abilities	Covariate	212,740	1	212,740	26,468	,000
	Covariate*Group	152,334	1	152,334	18,953	,000
	Error	199,226	77	199,226		
Total Score	Covariate	2168,044	1	2168,044	106,486	,000
	Covariate*Group	618,686	1	618,686	30,388	,000
	Error	882,356	77	882,356		

The results in table 6 indicate that the homogeneity test of regression coefficients for specialty scores had the following pre-test outcomes: Passing & Setting (F=4,730, p=,033 < ,05), Serving (F=13,934, p=,000 < ,001), In-game Abilities (F=18,953, p=,000 < ,001), and Total Score (F=30,388, p=,000 < ,001), demonstrating significant differences between the experimental and control groups. This suggests that the impact of covariates on both groups was not homogeneous, which contradicts the basic assumption of homogeneity of regression coefficients within groups for both tests. Therefore, covariance analysis for specialty scores was not further conducted (Li et al., 2017).

DISCUSSION

This study aimed to apply problem-based learning (PBL) to volleyball learning and examine its effects on volleyball skills. The results showed that a 12-week intervention of problem-based learning significantly improved volleyball specialty scores in passing & setting, serving, and in-game abilities compared to traditional classroom learning. Based on these experimental findings, it is recommended to incorporate problem-based learning into physical education, as problem-based learning methods are more effective than traditional classroom teaching methods (Alves et al., 2016; Luo, 2019). This may be attributed to the problem-based learning approach, which encourages students to focus on problem-solving, promotes deep learning, and enhances students' critical thinking skills to improve overall volleyball technique mastery. Additionally, simulated real coaching and game scenarios effectively enhance the application of overall technical skills (Marcinauskas et al., 2024).

These findings are consistent with similar studies; Prabandaru et al. (2020) demonstrated that problem-based learning is effective in improving badminton technical skills by requiring students to critically think about problems encountered in sports learning and how to solve them. Furthermore, PBL discussions and reflections deepen the interpretation of volleyball teaching materials and project characteristics, leading to improved accuracy and overall technical level through deep learning (Widigdo, 2021). Student-centered collaborative learning environments and mutual guidance and practice among members provide simulated opportunities to promote learning complex sports skills and develop integrated application abilities, effectively anticipating problems students may encounter in real-game scenarios and improving their sports skill levels (Li et al., 2022). Utami et al. (2022) suggested that the problem-based learning model increases knowledge and understanding through appropriate problem usage, as students focus on solving problems after identifying problem points, thereby improving their psychological motor processes, enhancing students' critical thinking abilities, and ultimately improving the learning effects of sports skills.

CONCLUSION

This study aimed to enhance the volleyball specialty scores of Chinese vocational college students through problem-based learning teaching methods. It was a quasi-experimental teaching design, with 41 students in the experimental group receiving problem-based learning teaching methods and 40 students in the control group receiving no intervention, with a 12-week intervention period. After 12 sessions of problem-based learning volleyball courses, both the experimental and control groups showed improvement in volleyball specialty scores from pre-tests to post-tests, with the experimental group scoring significantly higher than the control

group. In conclusion, problem-based learning effectively improves the volleyball specialty scores of Chinese university students.

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CONFLICT OF INTEREST

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