The Effect of Sport Education Model on Tennis-Specific Physical Fitness of College Students: An Empirical Study Based on Zhengzhou University

[1]Zi Yang, and [2*]Kreeta Promthep

[*]*Corresponding author*

[1]Graduate School, Udon Thani Rajabhat University, Thailand

[2*]Faculty of Education, Udon Thani Rajabhat University, Thailand

E-mail: [1]zzdxyz@iclould.com, [2*]kreeta.pr@udru.ac.th

Received April 2, 2026; **Revised** May 11, 2026; **Accepted** May 22, 2026

Abstract

This article aimed to study the effects of the Sport Education Model (SEM) on the tennis-specific physical fitness of male non-physical education majors in comparison with the traditional physical education teaching model. The sample consisted of 86 male sophomores enrolled in the public tennis elective course at Zhengzhou University in the first semester of the 2025–2026 academic year. They were selected using a purposive cluster sampling method and assigned to either an experimental group (SEM, n=43) or a control group (traditional model, n=43) through a quasi-experimental design with non-equivalent control groups. The instrument used for collecting data on physical fitness included three standardized tests: the overhead 2 kg medicine-ball throw (for strength), the fan-shaped run (for speed), and the hexagonal jump (for agility). Data analysis employed independent-samples and paired-samples t-tests. Results were as follows: 1) At the end of the 16-week intervention, the experimental group demonstrated statistically significant improvements in all three tennis-specific physical fitness indicators in comparison to their pre-test scores (fan-shaped run: 19.34±1.92 s to 18.07±1.76 s; hexagonal jump: 11.51±1.01 s to 10.36±1.15 s; medicine-ball throw: 7.45±1.15 m to 9.67±2.00 m; all $p<.001$), indicating large within-group effects. 2) Post-test comparisons indicated that the experimental group performed significantly better than the control group in all three indicators (fan-shaped run: $t = -2.39$, $p = .02$; hexagonal jump: $t = -3.72$, $p < .001$; medicine-ball throw: $t = 4.19$, $p < .001$), verifying the superiority of SEM over the traditional model. 3) The results suggest that SEM is more

effective in improving the tennis-specific physical fitness of male college novices, particularly in agility and strength, which may be related to its contextualized and competition-integrated training design.

Keywords: Sport Education Model; College Tennis Teaching; Tennis-Specific Physical Fitness; Strength; Speed; Agility

Introduction

In recent years, the Ministry of Education of China has issued key policies such as Opinions on Comprehensively Deepening Curriculum Reform and Implementing the Fundamental Task of Fostering Virtue Through Education and Guidelines for Physical Education Curriculum Teaching in National Regular Institutions of Higher Education, emphasizing that college physical education should prioritize students' holistic development, integrate moral, intellectual, and physical education, and promote teaching model reform to achieve the goal of "enjoying sports, strengthening physical fitness, improving personality, and tempering will". As a popular sport among college students, tennis courses are crucial for enhancing physical fitness and cultivating lifelong sports awareness. Previous research has also shown that college students' sports participation is influenced by psychological factors such as social physique anxiety and weight control self-efficacy, as well as media-internalized pressure (Ouyang et al., 2021). This perspective supports the use of learner-centered and socially structured models such as the Sport Education Model. Previous studies have identified critical limitations of this traditional model: Layne and Piipari (2015) found that its isolated physical fitness training (e.g., separate running or weight-bearing exercises) is disconnected from tennis technical application, leading to low training transfer efficiency. further noted that tennis-specific physical fitness (strength, speed, agility) has strong technical specificity—for example, lower limb and core explosive strength are essential for serving and forehand strokes—but traditional training fails to address this specificity. While the Sport Education Model (SEM), proposed by Siedentop et al. (2004), has been proven effective in improving physical fitness in team sports like basketball and volleyball (Ivashchenko, 2021) pointed out a clear research gap: empirical studies on its application in individual sports such as tennis are scarce, especially regarding its impact on tennis-specific physical fitness. Additionally, Kusnaedi et al. (2024) warned that direct replication of the Western-originated SEM may face "adaptation problems" in China's educational context, highlighting the need for localized optimization.

The research focuses on the field of college tennis teaching reform, targeting the core problem that traditional teaching models cannot effectively improve students' tennis-specific physical fitness and practical application abilities. The research team has long been engaged in physical education teaching reform and SEM application research, with prior experience in verifying the model's effectiveness in team sports. The research objects are non-physical education major male sophomores at Zhengzhou University—this group is representative of college tennis beginners, with homogeneous baseline physical fitness and no systematic tennis training experience, ensuring the validity of experimental comparisons. The target audience includes college physical education teachers, sports education researchers, and education policy makers, as the findings can provide practical guidance for tennis teaching practice and curriculum reform.

The core research objectives are as follows: first, to design a localized SEM teaching plan adapted to Chinese college tennis elective courses; second, to explore the impact of this localized model on students' tennis-specific physical fitness (strength, speed, agility) through a 16-week teaching experiment at Zhengzhou University; third, to compare the effectiveness of the localized SEM with the traditional teaching model.

The significance of this study is that it fills a clear gap in the literature on the application of the Sport Education Model (SEM) in individual sports, especially in college tennis. While positive effects of SEM have been shown in team sports, evidence for its effectiveness to improve tennis-specific physical fitness is limited. The study explores localized SEM teaching in tennis teaching in Chinese colleges, providing theoretical support for expanding the research field of SEM and practical guidance for physical education teaching, student fitness development, and lifelong sport participation.

Research Objectives

1. To examine the effects of the Sport Education Model (SEM) on college students' tennis-specific physical fitness (strength, speed, and agility) after the 16-week intervention.

2. To compare the changes in tennis-specific physical fitness between the experimental group and the control group following the intervention.

3. To determine whether the Sport Education Model is more effective than the traditional teaching model in improving college students' tennis-specific physical fitness.

Literature Review

The literature review systematically organizes and analyzes relevant studies on tennis-specific physical fitness, the impact of teaching models on physical fitness, and supporting theoretical frameworks, aiming to clarify the current research status, identify existing gaps, and lay a solid theoretical foundation for this study.

1. Theoretical Foundations of Physical Fitness in Tennis

Tennis-specific physical fitness transcends general fitness, emphasizing qualities directly linked to on-court performance. In constructing an evaluation system for university tennis players, concluded that strength quality holds the highest weight. Strokes like the forehand, backhand, and serve require coordinated force generation through leg drive, torso rotation, and kinetic chain sequencing. Similarly, agility and reactive speed are critical for covering the court and responding to an opponent's shots within typical movement patterns of 4-6 meters with sudden stops and starts. Traditional fitness training often isolates these components, whereas effective training should integrate them into sport-specific contexts (Zhou & Zheng, 2009).

2. Limitations of the Traditional PE Model in Developing Sport-Specific Fitness

The traditional model's "demonstration-imitation-repetitive practice" paradigm tends to separate skill practice from conditioned games and fitness development. Students engage in strength or speed drills that are not explicitly linked to their application in a tennis match. This DE contextualization can lead to a lack of transfer, where improvements in generic tests do not enhance actual gameplay. Furthermore, the repetitive nature can reduce student engagement, limiting the intensity and consistency of effort needed for physical improvement Layne and Piipari (2015). The Sport Education Model as a Vehicle for Contextualized Fitness Development.

SEM integrates physical conditioning into the fabric of the sport season. Fitness development occurs not as a separate warm-up or drill station but embedded within team practices, skill challenges linked to competition, and the competitive matches themselves. For instance, a "serving power challenge" or "baseline shuttle run point's competition" within the SEM framework directly ties improvements in explosive strength and movement speed to competitive objectives. This aligns with findings from Ivashchenko, (2021) who noted that students in SEM spent over 50% of class time in moderate-to-high intensity activity, and Layne and Piipari (2015). Who observed significant gains in sport-specific physical qualities through similar model-based interventions.

3. Research Gap and Localization Need

While domestic studies have validated SEM's effects in team sports like basketball and volleyball, research on its application to tennis-specific fitness is scarce. Existing studies, such as those by Wang et al. (2021), have begun to explore this area, noting significant improvements in indicators like fan-shaped run and hexagonal jump. However, these studies highlight the need for localized adaptations that address constraints common in Chinese universities, such as large class sizes and limited class hours, to effectively balance skill learning, competition, and fitness development within the SEM structure.

Summary of the literature review indicates that while the importance of tennis-specific fitness is well-established, traditional PE methods may not optimally develop it due to contextual disconnection. The SEM, with its emphasis on authentic, competition-driven learning, offers a theoretical framework for integrating fitness into skill and tactical development. However, empirical evidence focusing on its direct impact on the key physical fitness components for tennis in the Chinese college context remains limited, presenting a clear knowledge gap this research seeks to address.

Conceptual Framework

This research is a quasi-experimental study. The researcher defines the research conceptual framework based on the theory of the Sport Education Model (Siedentop et al., 2004) and the principles of sport-specific physical conditioning, together with the comparative analysis of teaching models. The details are as follows.

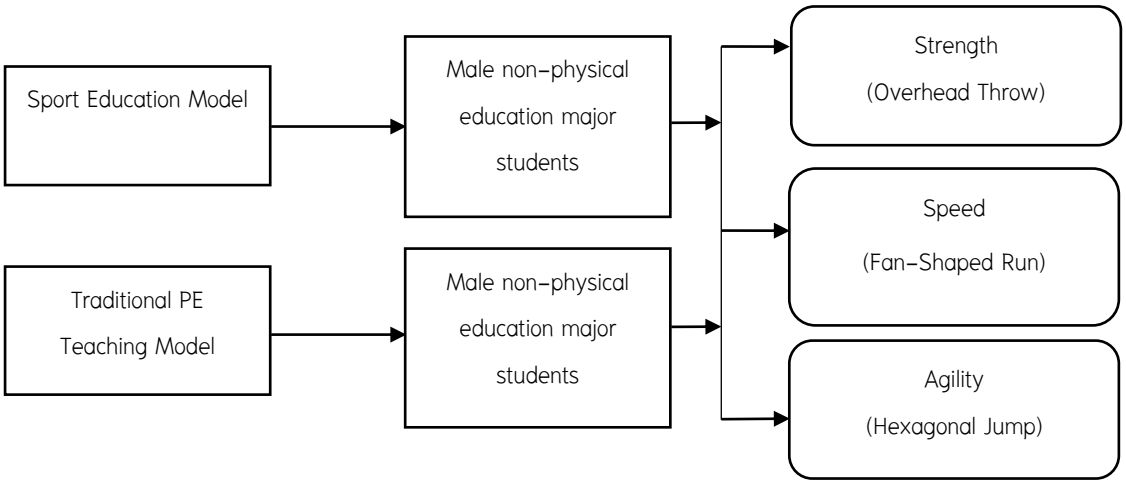


Figure 1 Conceptual Framework

Research Methodology

This study used a quasi-experimental pretest-posttest non-equivalent control group design. The research population was comprised of male sophomore students of the Zhengzhou University. The sample consisted of 86 students of two naturally occurring classes of tennis elective classes (2025–2026 academic year) who were selected through purposive cluster sampling. Because the classes had been formed before the study, it was not possible to randomly assign people. Pre-testing was conducted to verify that the two classes were comparable in all tennis-specific physical fitness measures ($p > .05$). One intact class was randomly assigned via a computer-generated random procedure at the class level to the experimental group ($n = 43$, receiving SEM) and the other to the control group ($n = 43$, receiving the traditional teaching model).

Ethics approval and consent to participate

The study was reviewed and approved by the Ethical Committee for Research in Human of Udon Thani Rajabhat University (Protocol No. 0622.7/528; Reference No. HECUD.175/2025). Participants provided written informed consent, and data were anonymized and used for research purposes only.

Research Instruments:

1. Tennis-Specific Physical Fitness Tests:

1.1 Strength: Overhead 2kg Solid-Ball Throw. Distance measured from throw line to landing point.

1.2 Speed: Fan-Shaped Run. Time recorded to collect 5 balls placed in a fan layout and place them on a racket.

1.3 Agility: Hexagonal Jump. Time recorded to complete two clockwise and counterclockwise circuits around a hexagon (side=60.5cm).

2. Procedure: Identical pre-tests were administered one week before the experiment. After the 16-week intervention, identical post-tests were conducted. The same researcher administered all tests to ensure consistency.

3. Experimental Intervention:

3.1 Experimental Group (SEM): Taught using a localized SEM framework. The 16-week semester was treated as a "season," divided into pre-season (skill acquisition), in-season (formal team competitions), and post-season (culminating championship). Students were in fixed,

heterogeneous teams, took on roles (e.g., coach, recorder), and participated in structured competitions. Fitness elements were integrated into team drills and competitive scenarios.

3.2 Control Group (Traditional Model): Taught using the standard "three-stage" model, focusing on teacher-led demonstration, repetitive technical drills, and general fitness exercises without competitive contextualization.

3.3 Controlled Variables: Same instructor (the researcher), syllabus, venue, equipment, and class hours (16 weeks, 1 session/week). A single-blind design was used where students were unaware of the experiment's comparative nature.

4. Data Analysis: Data were analyzed using SPSS software. Paired-samples T-tests were used to compare within-group changes (pre-test vs. post-test) for both groups. Independent-samples T-tests were used to compare post-test results between the experimental and control groups. Significance was set at $p < 0.05$.

Research Results

Objective 1. The results showed that there were no statistically significant differences in tennis-specific physical fitness (strength, speed, agility) between the experimental group (adopting the Sport Education Model, SEM) and the control group (adopting the traditional PE teaching model) before the 16-week teaching intervention, indicating homogeneous baselines that met the requirements of quasi-experimental design. As shown in Table 1, the pre-test results of the two groups were as follows: in the fan-shaped run (speed indicator), the experimental group scored 19.34 ± 1.92s and the control group scored 19.17 ± 1.96s (mean difference = 0.16, $t = 0.39$, $p = 0.70$); in the hexagonal jump (agility indicator), the experimental group scored 11.51 ± 1.01s and the control group scored 11.67 ± 1.03s (mean difference = −0.16, $t = -0.74$, $p = 0.46$); in the solid ball throw (strength indicator), the experimental group scored 7.45 ± 1.15m and the control group scored 7.34 ± 1.17m (mean difference = 0.12, $t = 0.46$, $p = 0.64$). The overall physical fitness score of the experimental group was 6.78 ± 0.95, and that of the control group was 6.86 ± 0.83 (mean difference = −0.09, $t = -0.47$, $p = 0.64$). All p-values were greater than 0.05, confirming that the two groups had comparable initial levels in tennis-specific physical fitness.

Table 1 Pre-test Homogeneity Test of Tennis-Specific Physical Fitness between Two Groups (M ± SD)

Indicators	Experimental Group	Control Group	Mean Difference	t	p
Fan-Shaped Run (s)	19.34 ± 1.92	19.17 ± 1.96	0.16	0.39	0.70
Hexagonal Jump (s)	11.51 ± 1.01	11.67 ± 1.03	-0.16	-0.74	0.46
Solid Ball Throw (m)	7.45 ± 1.15	7.34 ± 1.17	0.12	0.46	0.64

Objective 2. The results showed that both the experimental group and the control group achieved significant improvements in tennis-specific physical fitness after 16 weeks of teaching intervention, but the experimental group's improvement effect was significantly superior to that of the control group. For the control group, the post-test scores of fan-shaped run (19.00±1.85s), hexagonal jump (11.22±1.00s), and solid ball throw (8.08±1.49m) were all significantly higher than the pre-test scores. The hexagonal jump ($t=-3.75$, $p<0.001$) and solid ball throw ($t=4.60$, $p<0.001$) reached extremely significant differences, while the fan-shaped run ($t=-1.64$, $p=0.11$) showed no significant difference. The overall physical fitness score increased from 6.86±0.83 to 7.26±0.75 (mean difference = 0.39, $t = 5.86$, $p < 0.001$).For the experimental group, the post-test scores of the three indicators were 18.07±1.76s (fan-shaped run), 10.36±1.15s (hexagonal jump), and 9.67±2.00m (solid ball throw), all showing highly statistically significant improvements compared with the pre-test ($p < 0.001$). The overall physical fitness score rose from 6.78±0.95 to 8.13±0.69 (mean difference = 1.36, $t = 8.22$, $p < 0.001$). The magnitude of improvement in the experimental group was significantly greater than that of the control group.

Table 2 Intra-group Comparison of Tennis-Specific Physical Fitness before and After Intervention (M ± SD)

Indicators	Group	Pre-test	Post-test	Mean Difference	t	p
Fan-Shaped	Experimental	19.34 ± 1.92	18.07 ± 1.76	-1.27	-3.15	0.00**
Run (s)	Control	19.17 ± 1.96	19.00 ± 1.85	-0.17	-1.64	0.11
Hexagonal	Experimental	11.51 ± 1.01	10.36 ± 1.15	-1.15	-4.83	0.00**
Jump (s)	Control	11.67 ± 1.03	11.22 ± 1.00	-0.45	-3.75	0.00**
Solid Ball	Experimental	7.45 ± 1.15	9.67 ± 2.00	2.22	5.94	0.00**
Throw (m)	Control	7.34 ± 1.17	8.08 ± 1.49	0.74	4.60	0.00**

Note: **$p < 0.01$, indicating a highly statistically significant difference.

Objective 3. The results showed that after the intervention, the experimental group's tennis-specific physical fitness indicators were significantly higher than those of the control group, with statistically significant or highly statistically significant differences between the two groups.

Fan-Shaped Run: experimental group (18.07±1.76s) vs. control group (19.00±1.85s) (mean difference = −0.93, t = −2.39, p = 0.02*);

Hexagonal Jump: experimental group (10.36±1.15s) vs. control group (11.22±1.00s) (mean difference = −0.86, t = −3.72, p < 0.001**);

Solid Ball Throw: experimental group (9.67±2.00m) vs. control group (8.08±1.49m) (mean difference = 1.59, t = 4.19, p < 0.001**);

Overall Physical Fitness: experimental group (8.13±0.69) vs. control group (7.26±0.75) (mean difference = 0.88, t = 5.99, p < 0.001**).

These results fully confirm that the SEM is more effective than the traditional teaching model in improving college students' tennis-specific physical fitness, especially in enhancing agility, strength and speed.

Table 3 Post-intervention Inter-group Comparison of Tennis-Specific Physical Fitness (M ± SD)

Indicators	Experimental Group	Control Group	Mean Difference	t	p
Fan-Shaped Run (s)	18.07 ± 1.76	19.00 ± 1.85	−0.93	−2.39	0.02*
Hexagonal Jump (s)	10.36 ± 1.15	11.22 ± 1.00	−0.86	−3.72	0.00**
Solid Ball Throw (m)	9.67 ± 2.00	8.08 ± 1.49	1.59	4.19	0.00**

Note: *p < 0.05, indicating a statistically significant difference; **p < 0.01, indicating a highly statistically significant difference.

Discussions

The most important finding of this study is that students in the SEM group demonstrated significantly greater improvement than those in the traditional teaching group in tennis-specific physical fitness, especially in strength and agility. This finding is consistent with previous studies showing that the Sport Education Model can produce better learning outcomes than traditional instruction by increasing students' engagement in meaningful, structured, and sport-related tasks. Layne and Piipari reported that university students taught through SEM achieved better basketball game performance and content knowledge than those taught through a traditional approach, while Chu et al. found that SEM was more effective than traditional physical education in promoting college students' learning motivation, affective learning, cognition, and behavior. At a broader

level, systematic review evidence has also shown that SEM supports students' intrinsic motivation, basic psychological needs, and prosocial attitudes, which are important conditions for sustained participation and effective learning. In a wider context, evidence from systematic reviews has also demonstrated that SEM promotes students' intrinsic motivation, basic psychological needs, and prosocial attitudes, which are critical for lasting engagement and effective learning (Layne & Piipari, 2015; Chu et al., 2022).

The enhancement of strength and agility in the present study may be particularly pronounced because of the structural features of SEM, such as team membership, role responsibility, formal competition, and repeated practice in a game-like setting. These characteristics require students to perform repeated changes of direction, explosive movements and contextualized physical efforts, all highly pertinent to tennis performance. More recent university-based research also supports this interpretation by showing that SEM can have an enhancing effect on physical literacy and daily physical activity through motivational mechanisms. Moreover, meta-analytic evidence demonstrates an overall positive effect of SEM on physical education learning outcomes. Thus, the present findings not only support previous SEM research, but extend it by suggesting that, in college tennis instruction, SEM may be particularly effective to improve physical fitness components closely tied to authentic sport situations (Manninen & Campbell, 2021; Choi et al., 2024).

New Knowledge from Research

This study confirmed the applicability of the localized Sport Education Model (SEM) in college tennis elective courses. Its core structural elements—seasons, team affiliation, formal competition, and role assignment—create a contextualized learning environment where skills and fitness are trained within game-like, competitive scenarios. The result is superior improvement in key components of tennis-specific physical fitness (strength, agility, and contextual speed), while also supporting holistic physical education goals by improving performance, motivation, and laying a foundation for lifelong sport participation.

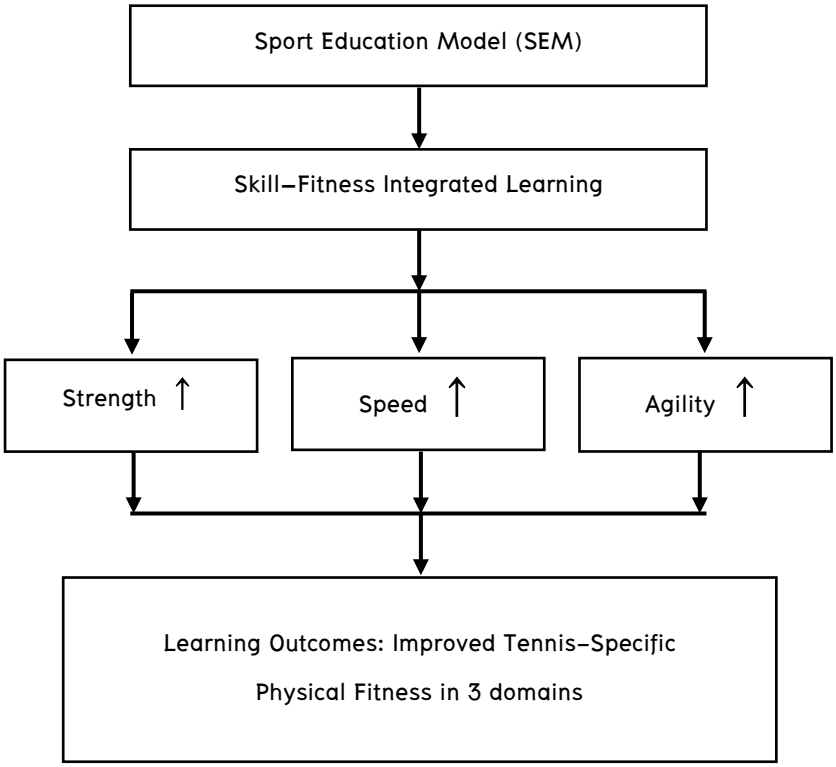


Figure 2 New Knowledge from Research

Conclusion

1. Before the intervention, the two groups of college students had homogeneous baselines in tennis-specific physical fitness (strength, speed, agility), with all $p>0.05$, which ensured the validity of the experimental comparison.

2. After 16 weeks of teaching intervention, both the SEM experimental group and the traditional teaching control group showed significant improvements in tennis-specific physical fitness. The experimental group improved extremely significantly in all three indicators ($p<0.001$), while the control group only improved significantly in hexagonal jump and solid ball throw.

3. The SEM is significantly superior to the traditional teaching model in improving college students' tennis-specific physical fitness. The experimental group's scores in strength, speed, agility, and overall physical fitness are all significantly higher than those of the control group, and the improvement range is 2–3 times that of the control group.

4. The localized SEM adapted to Chinese college tennis teaching has good applicability and effectiveness, and can be used as an effective teaching model to improve college students' tennis-specific physical fitness.

Suggestions

1. Teaching Practice Suggestions

Popularize the localized SEM in college tennis elective courses: Colleges and universities should encourage physical education teachers to apply the SEM in tennis teaching, and design teaching plans according to the actual situation of students (such as class size, technical foundation, and class hours) to improve the effectiveness of physical fitness training.

Strengthen the integration of physical fitness training and competitive scenarios: In tennis teaching, physical fitness training should be integrated into game-based activities and competitions, avoiding isolated training, so that students can improve their physical fitness in the process of applying technical skills.

Give full play to the role of team cooperation: In the SEM teaching, reasonable grouping and role assignment should be carried out to encourage team members to supervise and help each other in physical training, and cultivate students' sense of collective honor and cooperative spirit.

2. Curriculum Design Suggestions

Optimize the curriculum structure of the SEM: According to the 16-week semester of Chinese colleges and universities, reasonably arrange the pre-season, mid-season, and post-season teaching content, and ensure sufficient time for physical fitness training while focusing on technical learning.

Formulate personalized physical fitness training plans: According to the differences in students' physical fitness and technical levels, formulate targeted training plans, such as arranging additional strength training for students with weak serving strength and additional speed training for students with slow movement.

3. Teacher Training Suggestions

Strengthen teacher training on the SEM: Colleges and universities should organize special training workshops to help physical education teachers master the core concepts, implementation steps, and localized optimization methods of the SEM, and improve their ability to apply the model in teaching.

Improve teachers' ability to design physical fitness training: Guide teachers to combine the characteristics of tennis and the SEM to design scientific and effective physical fitness training activities, and improve the pertinence and effectiveness of training.

These recommendations are consistent with broader calls for the application of best practices in health, physical education, and sport to strengthen educational quality and student outcomes (Ivashchenko, 2021).

References

Choi, S. M., Wang, F., Sum, R. K. W., Ching, B. H., Leung, E. F. L., & Ho, R. W. K. (2024). The motivational impact of sport education model on daily physical activity levels among university students: A mediation analysis. *Scientific Reports, 14*(1), 27964. https://doi.org/10.1038/s41598-024-78446-8

Chu, Y., Chen, C., Wang, G., & Su, F. (2022). The effect of education model in physical education on student learning behavior. *Frontiers in Psychology, 13*, 944507. https://doi.org/10.3389/fpsyg.2022.944507

Ivashchenko, C. M. (2021). Health, physical education and sport: Perspectives and best practices: In *Book of Abstracts of the 3rd International scientific and practical online conference*, 12–13 May, 2021, Kyiv. In Borys Grinchenko Kyiv University eBooks. https://doi.org/10.28925 /2021.51213168conf

Kusnaedi, K., Kusnaedi, P. N. S., Hidayat, Y., & Carsiwan, C. (2024). Penerapan Model Teaching Personal and Social Responsibility (TPSR) untuk Meningkatkan Kemandirian Siswa di SMP. *Jurnal Sains Keolahragaan Dan Kesehatan, 9*(2), 227–235. https://doi.org/10.5614/jskk.2024.9.2.7

Layne, T. E., & Piipari, S. Y. (2015). Effects of the sport education model on university students game performance and content knowledge in basketball. *Journal of Sports Research, 2*(2), 24–36. https://doi.org/10.18488/journal.90/2015.2.2/90.2.24.36

Manninen, M., & Campbell, S. (2021). The effect of the Sport Education Model on basic needs, intrinsic motivation and prosocial attitudes: A systematic review and multilevel meta-analysis. *European Physical Education Review, 28*(1), 78–99. https://doi.org/10.1177/1356336x211017938

Ouyang, Y., Luo, J., Teng, J., Zhang, T., Wang, K., & Li, J. (2021). Research on the influence of media internalized pressure on college students' sports participation–chained intermediary analysis of social physique anxiety and weight control self–efficacy. *Frontiers in Psychology, 12*, 654690. https://doi.org/10.3389/fpsyg.2021.654690

Siedentop, D., Hastie, P., & van der Mars, H. (2004). *Sport education: Quality PE through positive sport experiences*. (3rd ed.). Illinois: Human Kinetics.

Wang, J. et al. (2021). Current situation and reform path of college physical education teaching in China. *Journal of Beijing Sport University, 44*(3), 105–112.

Zhou, H. X., & Zheng, J. Y. (2009). *Manual of physical and psychological training for tennis players.* Beijing: People's Sports Publishing House.