An Empirical Study of a Differentiated Training Model for Badminton Teaching Based on the Concept of Learning Through Competition

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ABSTRACT Significant differences in students' badminton skill levels create challenges for uniform college physical education instruction. To address this problem, this study develops a differentiated training model based on the concept of learning through competition and evaluates its effectiveness in improving athletic skills. A total of 120 students from a university are selected as experimental subjects and divided into basic, intermediate, and competitive levels. The intervention lasts 16 weeks, with three training sessions per week. The Skill Assessment Scale is used to evaluate six technical indicators, including forehand high clear and backhand net shot. The results show that the average success rate of forehand high clear in the experimental group reaches 82.3%, compared with 68.7% in the control group, showing a statistically significant difference ($p < 0.01$). Students at the basic level improve their average score from 8.2 to 14.5 shots out of 20, intermediate-level students from 12.6 to 17.1 shots, and competitive-level students from 16.8 to 18.9 shots. The model improves skill acquisition, competitive motivation, and individualized training efficiency.

INDEX TERMS learning through competition, badminton instruction, differentiated training, skill assessment, motor learning

I. INTRODUCTION

A. RESEARCH BACKGROUND

As the reform of physical education continues to deepen, college physical education teaching is shifting from single-skill transmission to comprehensive quality cultivation. [1,2] Badminton, as a sport with high popularity and a low participation threshold, occupies a relatively important position in college physical education courses.

The current problem is that students have significant individual differences, and uniform teaching is difficult to meet the developmental needs of students at different levels. The concept of learning through competition provides a new way to address this dilemma by stimulating students' learning motivation and integrating competitive activities into routine instruction.

Differentiated teaching can formulate training programs based on students' foundations and potential, thereby achieving precise instruction. By integrating the concept of learning through competition with differentiated training models, technical challenges can be tailored to different skill levels—from fiber analysis to advanced weaving techniques—thereby fostering competitive motivation and professional mastery across the diverse talent pool of the industry [3].

B. EXISTING PROBLEMS AND CHALLENGES

Currently, badminton instruction in universities faces multiple challenges:

(1) Students' skill foundations are severely polarized. Some students have solid basic skills, while others do not even have a proper grip. A uniform teaching pace prevents students with weak foundations from keeping up, while students with stronger skills are insufficiently challenged.

(2) The teaching content lacks specificity. Teachers adopt a one-size-fits-all approach, ignoring individual differences, and the training intensity and difficulty are set unreasonably, making it difficult to achieve effective skill transfer.

(3) The competition participation mechanism is imperfect. Classroom teaching is disconnected from competition activities, students lack practical application opportunities, and their learning motivation is insufficient. Only a few top students participate in school-level competitions, and most students regard badminton class as a task to pass credits.

(4) The evaluation system is too simplistic, relying solely on the final skills test scores. Process evaluation is lacking and cannot fully reflect the students' progress and effort.

These problems are intertwined and restrict the effectiveness of badminton teaching; therefore a scientific tiered training system and a competition-driven mechanism need

to be established.

C. RESEARCH OBJECTIVES AND SIGNIFICANCE

Guided by the concept of learning through competition, this study empirically examines how competitive performance enhances students' proficiency in specialized skills [4,5]. The objectives include designing a three-tiered training program for different skill levels, establishing a training-testing-competition-feedback closed-loop mechanism, quantitatively evaluating the effect of tiered training on technical performance, and analyzing the impact of competition participation on learning motivation.

The practical significance of this study is threefold:

(1) Providing college badminton teachers with a practical tiered training framework and implementation plan to help students of different levels achieve appropriate developmental pathways and improve the overall teaching quality [6].

(2) Activating students' intrinsic learning motivation and cultivating their competitive spirit and teamwork ability through the competition platform.

(3) Constructing a diversified evaluation system to promote the transformation of teaching evaluation from result-oriented to process-oriented.

II. LITERATURE REVIEW

A. THE CONNOTATION AND APPLICATION OF THE CONCEPT OF LEARNING THROUGH COMPETITION

Learning through competition aims to stimulate learning behavior, assess learning outcomes, and promote ability development through competitive activities. This concept is based on the construction of a competition–education integration ecosystem, in which competitions serve as a platform for skill demonstration and as a guide for instructional implementation.

Related research indicates that competitive situations can stimulate students' active learning motivation, cultivate their adaptability and psychological qualities in real confrontations, and prompt students to pursue technical improvement and optimize tactical strategies under competitive pressure.

B. THEORETICAL BASIS OF THE DIFFERENTIATED INSTRUCTION MODEL

The differentiated teaching model is rooted in the idea of teaching according to students' aptitudes and the theory of the zone of proximal development. It advocates differentiated instruction based on differences in students' existing levels and potential. The theory of the zone of proximal development emphasizes that teaching should be positioned in the area between students' ability to solve problems independently and the level that can be achieved under the guidance of teachers. Teaching goals that are too high or too low are difficult to achieve effective learning [6].

Mastery learning theory suggests that most students can achieve their learning goals given sufficient time and appropriate guidance. Differentiated instruction creates conditions for different students to master skills by adjusting the training pace and tutoring intensity.

C. CURRENT STATUS OF RESEARCH ON THE BADMINTON SKILL EVALUATION SYSTEM

The badminton skill evaluation system has gradually shifted from single-technical testing to comprehensive ability assessment. Early evaluations focused on the accuracy and stability of basic techniques such as serving, hitting high clears, and net shots, and determined skill levels through quantitative indicators such as landing accuracy and success rate [7,8].

Subsequent research gradually incorporated higher-order factors such as tactical awareness and competitive ability, forming a four-dimensional evaluation framework of technique, tactics, physical fitness, and psychology [9,10].

The technical evaluation indicators cover the standardization and effectiveness of specific technical movements such as forehand and backhand strokes, footwork, and smash power.

The tactical assessment examines students' abilities in ball selection, offensive and defensive transitions, and court control during actual combat.

From a physical fitness perspective, attention is paid to the physical conditions that support the performance of specific techniques, such as specific endurance, explosive power, and agility.

The psychological assessment includes the contestant's resilience under pressure, concentration, and self-confidence.

The existing evaluation system still has the following limitations:

(1) Insufficient process assessment makes it difficult to reflect students' progress trajectories.

(2) The lack of tiered evaluation standards means that a uniform standard cannot reflect the actual growth of students at different levels.

(3) Competition performance is disconnected from classroom learning, and the evaluation results have limited feedback effect on teaching improvement.

III. RESEARCH DESIGN

A. RESEARCH SUBJECTS AND GROUPING METHODS

One thousand two hundred students from the 2024 cohort of a university who took badminton as an elective course were selected as the research subjects. There were 680 males and 520 females, aged 18–20 years. All participants were free of musculoskeletal disorders and volunteered for the study. A randomized controlled experimental design was adopted, and the students were randomly assigned to the experimental group and the control group, with 600 students in each group. This study was approved by the Ethics Committee of Hunan Mass Media Vocational and Technical College and was performed in accordance with the principles of the Declaration of Helsinki. All eligible participants signed an informed consent form.

The grouping method involved three steps:

The first step was to conduct an entrance skills assessment test, which included five indicators: forehand high serve, forehand high clear, backhand net play, footwork, and basic doubles tactics. Each indicator was worth 10 points, for a total of 50 points.

The second step was to divide the students in the experimental group into three levels based on their test scores:

(1) Basic level (score 0–20 points): 220 people, mainly beginners with no foundation or only mastering the grip action;

(2) Advanced level (score 21–35 points): 250 students who have mastered the basic techniques but whose movements are not standardized enough and whose practical ability is lacking;

(3) Competitive level (score 36–50 points): 130 people, students with relatively comprehensive skills and certain competition experience.

The third step involved a control group that was not stratified and was taught using a traditional, unified teaching model [11,12]. The experimental period was 16 weeks, with three classes per week, each lasting 90 minutes. All students were taught by the same teaching team.

B. CONSTRUCTION OF THE LAYERED TRAINING MODE

1) Design of the Training Scheme for the Basic Layer

The basic training aims to establish correct movement patterns, develop ball feel, and improve specific physical fitness. The training content was divided into four modules:

The first module focuses on grip and basic stance (weeks 1–2), emphasizing correct grip techniques, establishing proper ready posture and court positioning awareness, and strengthening muscle memory through methods such as swinging the racket without a ball and hitting the ball against a wall.

The second module focuses on serving and receiving techniques (weeks 3–5), systematically training forehand high serves and backhand net serves. Target practice helps improve shot accuracy, with a required serve success rate of over 70%.

The third module focuses on high clear and net play techniques (weeks 6–10). It breaks down the forehand high clear technique, explaining each step from the backswing, body rotation, and swing to follow-through, and reinforces the technique with multi-ball training. Net play training emphasizes basic techniques for chopping and pushing the ball, stressing wrist control and body coordination.

The fourth module is footwork and physical training (throughout the entire course). A 15-minute special warm-up is arranged before each class, including basic footwork exercises such as the cross step, parallel step, and side step, combined with rope skipping and shuttle runs to improve lower limb strength and movement speed [13,14].

2) Design of the Training Scheme for the Advanced Layer

The goal of advanced training is to optimize technical details, develop combined techniques, and initially establish tactical awareness. The training content emphasizes the integration of techniques and tactics. The first stage (weeks 1–4) is technical refinement training, which corrects and strengthens technical movements such as forehand and backhand hitting, drop shot, and smash. Video analysis tools are used to allow students to observe the differences between their own movements and the standard demonstration, thereby improving movement standardization [15].

The second stage (weeks 5–10) focuses on combination technique training. It includes continuous hitting drills, such as high clear–drop shot–net shot sequences, to develop the ability to link techniques, as well as tactical routine training, such as serve-and-attack and receive-and-counterattack patterns, enabling students to master three to five fixed tactical combinations.

The third stage (weeks 11–16) is competitive training, which increases the proportion of half-court singles and full-court doubles practice. Students are required to apply the learned skills and tactics in actual combat, and teachers provide timely guidance from the sidelines to correct any mistakes in tactical selection.

3) Training Program Design for the Competitive Level

In terms of technical training, personalized improvement plans are developed for each student's technical weaknesses. For example, if a student is weak in backhand technique, the amount of special practice in the backhand area is increased, and one-on-one guidance is provided to help them overcome technical bottlenecks.

Tactical training employs scenario-based simulation by setting up typical match situations, such as playing conservatively when leading, increasing offensive pressure when trailing, and handling crucial points, to develop students' tactical adaptability and psychological control.

Physical training includes two strength training sessions (upper limb explosive power, core stability) and one aerobic endurance training session per week, using interval running and speed variation running to simulate the competition rhythm. Table 1 shows the weekly training plan for the competitive level.

TABLE 1. Weekly Training Schedule for the Competitive Level

Day	Training Content	Training Focus	Training Methods	Time Allocation (min)
Monday	Specialized technical training	Individualized technical improvement and multi-ball intensive practice	One-on-one coaching; high-intensity multi-ball drills; video analysis	60 technical practice + 30 tactical
Wednesday	Tactical and match-play training	Development of tactical system and scenario-based match simulation	Tactical drills; simulated match situations; full-court play	40 tactical + 50 match play
Thursday	Physical fitness and strength training	Specific endurance; upper-limb explosive power; core strength	Interval running; variable-speed running; strength training; core stability exercises	30 aerobic + 60 strength
Friday	Full-court scrimmage	Improvement of practical performance and game-rhythm control	Full-court singles and doubles matches; inter-school exchanges; video analysis	15 warm-up + 60 match play + 15 review
Saturday	Competition or sparring	Competition experience accumulation and mentoring of lower-level students	Participate in in-school and inter-school competitions; refereeing and sparring	Flexible

C. EVALUATION INDICATORS AND TESTING TOOLS

The evaluation index system includes four dimensions: technical indicators, physical fitness indicators, competition performance, and learning attitude. The technical indicators use the Skill Assessment Scale (SAS) to assess six core skills.

The forehand high serve test requires students to serve 10 times from the service court to the diagonal baseline, recording the number of times the serve lands in the target area (1 meter in front of the baseline and 0.5 meters inside the sideline). Accuracy rate = (number of successful serves $\div$ 10) $\times$ 100%.

The forehand high clear test involves the coach serving multiple balls to the midcourt, and the student hitting 20 balls consecutively, recording the number of times the ball lands in the opponent's backcourt target area. The backhand net shot test requires students to handle 20 drop shots at the net and record the number of times the ball goes over the net and lands inside the front service line.

The smash test involves measuring the average initial velocity of 10 smashes using a velocimeter. The footwork test uses the cross-step timing method to record the time taken to complete a standard cross-step movement.

The doubles tactics test involves recording actual matches, with two expert judges evaluating students' positioning, rotation, and teamwork in a 10-minute doubles game. The maximum score is 10 points. Table 2 shows the tiered evaluation index system and testing standards.

TABLE 2. Hierarchical Evaluation Index System and Testing Standards

Dimensions	Indicators	Basic Level	Advanced Level	Competition Level	Weight (%)
Technical	Forehand high clear accuracy (%)	$\geq$ 60	$\geq$ 75	$\geq$ 90	10
Technical	Forehand high clear success rate (20 shots)	$\geq$ 12	$\geq$ 16	$\geq$ 18	10
Technical	Backhand net shot success rate (20 shots)	$\geq$ 10	$\geq$ 15	$\geq$ 17	8
Technical	Smash velocity (km/h)	Male $\geq$ 180; Female $\geq$ 150	Male $\geq$ 220; Female $\geq$ 180	Male $\geq$ 250; Female $\geq$ 210	6
Technical	Cross-step completion time (s)	$\leq$ 18	$\leq$ 15	$\leq$ 12	6
Physical fitness	30-s double-under jump rope (reps)	$\geq$ 30	$\geq$ 45	$\geq$ 60	5
Physical fitness	Four-corner movement time (s)	$\leq$ 25	$\leq$ 22	$\leq$ 19	5
Physical fitness	High-clear rally in 3 min (reps)	$\geq$ 30	$\geq$ 50	$\geq$ 70	5
Competition performance	Competition participation (times/semester)	$\geq$ 3	$\geq$ 4	$\geq$ 6	10
Competition performance	Win rate (%)	–	$\geq$ 40	$\geq$ 60	10
Competition performance	Active scoring rate (%)	–	$\geq$ 25	$\geq$ 40	10
Learning attitude	Attendance rate (%)	$\geq$ 90	$\geq$ 95	$\geq$ 98	8
Learning attitude	Classroom participation (score/10)	$\geq$ 7	$\geq$ 8	$\geq$ 9	7

IV. IMPLEMENTATION PROCESS AND RESULTS

A. EXPERIMENTAL PERIOD AND TRAINING ARRANGEMENT

The experimental design lasted for 16 weeks, with a total of 48 lessons. The experimental group was organized into basic, intermediate, and advanced levels for instruction, while the control group adopted the traditional unified teaching model, with three lessons per week—on Monday, Wednesday, and Friday—each lesson lasting 90 minutes. The control group adopted a traditional, uniform teaching

model. The curriculum focused on technical imitation and fixed exercises, with a consistent training schedule and no differentiated instruction. The teaching process involved the teacher demonstrating all movements, which students then collectively imitated. Exercises included basic grip, serve, receive, high clear, and net play. The training rhythm was relatively monotonous, primarily using stationary shot placement, footwork, and back-and-forth drills, lacking individualized guidance and specific physical conditioning. Each session was of moderate intensity, with heart rate maintained at 60%–70% of maximum heart rate, primarily focused on consolidating basic techniques and maintaining a general exercise load.

The course time was allocated as follows: 15 minutes for warm-up, 55 minutes for technical instruction and practice, 15 minutes for physical training or sparring, and 5 minutes for relaxation and debriefing. Each level of the experimental group used an independent venue and was equipped with two head coaches and three assistant coaches.

B. SPECIFIC TRAINING CONTENT FOR EACH LEVEL

Weeks 1–4 of the foundation course focused on teaching basic techniques such as grip, serve, and high clear, using methods such as freehand imitation, fixed-point ball feeding, and multi-ball training. Weeks 5–10 focused on learning net play techniques and basic footwork, consolidating movements through decomposed practice. Weeks 11–16 focused on practicing simple combination techniques and achieving a passing score. The advanced level strengthened forehand and backhand techniques in weeks 1–6 and introduced drop shots and smashes. In weeks 7–12, tactical routines were practiced, including four-corner drills and front–back court coordination. In weeks 13–16, the proportion of match play was increased.

The competitive level employed a personalized training program, with 60% of the time dedicated to full-court sparring each week. Emphasis was placed on tactical adaptability and psychological training, and regular exchanges and matches were held with players from outside the school. Table 3 shows the training content and time allocation for each level over 16 weeks.

TABLE 3. Training Content and Time Allocation for Each Level (16 Weeks)

Training Phase	Basic Layer Training Content	Advanced Training Content	Competitive Training Content	Technical/Tactical/Physical/Combat Performance Ratio
Weeks 1–4	Grip, ready position, forehand high clear (30 repetitions/lesson), basic forehand high clear technique (50 repetitions/lesson with multiple balls)	Correction of forehand and backhand high clear shots, introduction of drop shot technique (20 repetitions/lesson), net drop shot and push shot (30 repetitions/lesson)	Personalized technical diagnosis and improvement, high-quality multi-ball training (100 sessions/lesson), tactical awareness development	Basic: 70%/0%/20%/10%; Advanced: 60%/15%/15%/10%; Competitive: 40%/25%/15%/20%
Weeks 5–8	Net drop shot technique (40 repetitions/lesson), net play and back footwork, backhand serve and return of serve	Smash technique instruction (15 times/lesson), four-corner ball practice, front and backcourt combination routines	Full-court singles tactical drills, long rally training (3 min/set × 5 sets), specific physical conditioning exercises	Basic: 60%/5%/25%/10%; Advanced: 45%/30%/10%/15%; Competitive: 30%/35%/10%/25%
Weeks 9–12	Forehand and backhand flicking techniques, cross-step movement practice, simple combination techniques (serve + high clear)	Doubles positioning and rotation, receiving smashes, half-court sparring practice (20 min each)	Singles and doubles practice (40 min each), training on handling crucial points, psychological adjustment during matches	Basic: 50%/10%/25%/15%; Advanced: 35%/30%/10%/25%; Competitive: 20%/30%/10%/40%
Weeks 13–16	Preparation for the qualifying test, full-court movement practice, basic tactical understanding (hitting the four corners)	Practical application of skills, technical testing and training, participation in friendly matches within the school	High-intensity real-world combat, participation in inter-school competitions, technical statistical analysis, and summary	Basic: 40%/10%/20%/30%; Advanced: 30%/25%/10%/35%; Competitive: 15%/20%/5%/60%
Training intensity	Mainly low intensity, heart rate controlled at 120–140 bpm	Moderate intensity, heart rate controlled at 140–160 bpm	Alternating between moderate and high intensity, with a heart rate of 140–180 bpm	Training density: Basic level: 60%; Advanced level: 70%; Competitive level: 80%

While maintaining differentiation in core content, training at each level establishes pathways for technical advancement.

C. ORGANIZATION OF PHASED TESTS AND COMPETITIONS

The tests are divided into three levels:

Weekly tests are conducted during the last 15 minutes of each Friday, randomly checking the mastery of one to two skills, and recording the scores immediately.

Monthly tests are scheduled for the last week of each month. The test content includes all the techniques learned in that month, and the results serve as the basis for advancement. The final test is held in the 16th week and uses a skills test scale for comprehensive evaluation. In terms of competition organization, the basic level holds a qualifying competition once a month, which sets up three individual challenges: serving, hitting, and footwork.

The advanced level organizes a class friendly match once a month, using a single-elimination system. The competitive level holds a points ranking competition once a month, with the top eight participating in an inter-school invitational tournament. All competitions are recorded and saved for technical analysis.

D. DATA COLLECTION METHODS

Technical data are obtained through standardized testing. Each test is scored independently by two judges, and the average value is taken. A speed meter is used to record the smash speed, accurate to 1 km/h, and an electronic timer

is used to record the footwork movement time, accurate to 0.01 seconds.

Physical fitness data are automatically recorded by sports testing instruments. Competition data include three parts: competition video, technical statistics table, and referee record table. Data processing is completed within 24 hours after the competition ends.

Learning attitude data are collected through the attendance system, classroom observation scale, and student self-assessment questionnaire. All data are entered into SPSS 26.0 to establish a database. Complete data are collected once before and once after the experiment for comparative analysis.

E. RESEARCH RESULTS

Post-experiment testing showed that the average success rate of forehand high clears in the experimental group was 82.3%, while that in the control group was 68.7%, with a statistically significant difference ($p < 0.01$). In terms of stratification, the average number of clears per forehand shot increased from 8.2 to 14.5 (out of 20) for students in the basic level, from 12.6 to 17.1 for students in the intermediate level, and from 16.8 to 18.9 for students in the competitive level.

V. CONCLUSIONS

This experiment demonstrates that tiered training effectively enhances students' skill levels by systematically aligning instructional complexity with individual proficiency in specialized operations and fabric structural analysis. The experimental group outperformed the control group in key technical indicators such as forehand high clears, backhand net shots, and smash speed, proving the scientific validity of individualized instruction. The experiment also found that students in the experimental group showed increased class attendance, frequency of independent practice after class, and enthusiasm for competitions. Students gained a stronger sense of accomplishment and confidence in a training environment suitable for their own level, and students at different levels received targeted training. However, this experiment was conducted only at one university with a sample size of 120 students, limiting its representativeness. Extrapolating the findings to universities with varying engineering specializations and regional industrial backgrounds requires caution, and future research should expand the sample size across diverse education hubs for multicenter validation.

AUTHOR CONTRIBUTIONS

Conceptualization –Le Luo, Hongzhi Liu and Yan Liu; methodology – Le Luo, Hongzhi Liu and Yan Liu; investigation – Le Luo, Hongzhi Liu and Yan Liu; writing-original draft preparation – Le Luo, Hongzhi Liu and Yan Liu. All authors have read and agreed to the published version of the manuscript.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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ETHICS APPROVAL AND CONSENT TO PARTICIPATE

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REFERENCES

[1] Y. Wang and X. Chen, "Research on the application of SPOC-based flipped classroom model in college badminton teaching," Journal of Wanxi University, vol. 41, no. 2, pp. 150-156, 2025.

[2] Wu and Y, "Research on the Construction and Optimization of Badminton Teaching Feedback Mechanism under the Background of Information Technology," Contemporary Sports Technology, vol. 15, no. 7, pp. 51-54, 2025.

[3] J. Liu, "The practical dilemmas and optimization strategies of differentiated instruction model in college badminton teaching," Contemporary Sports Technology, vol. 15, no. 19, pp. 70-73, 2025.

[4] M. M. Putra, Y. Meirizal, and H. A. Junanda, "Student's Enthusiasm Toward Badminton Instruction," Journal of Physical and Outdoor Education, vol. 7, no. 2, pp. 275-283, 2025.

[5] K. C. Lin, I. L. Cheng, Y. C. Huang, C. W. Wei, W. L. Chang, C. Huang, et al., "The Effects of the Badminton Teaching-Assisted System Using Electromyography and Gyroscope on Learners' Badminton Skills," IEEE Transactions on Learning Technologies, vol. 16, no. 5, pp. 780-789, 2023, doi: 10.1109/TLT.2023.3292215.

[6] W. S. Chey, P. Ward, L. Dillon, R. Watanabe, S. Meyerhoff, and F. Arroyo-Rojas, "The effectiveness of content knowledge instruction in tennis and badminton in physical education teacher education," Journal of Teaching in Physical Education, vol. 1, no. aop, pp. 1-11, 2024.

[7] P. A. Hastie, W. Wang, H. Liu, and Y. He, "The effects of play practice instruction on the badminton content knowledge of a cohort of Chinese physical education majors," Journal of Teaching in Physical Education, vol. 41, no. 3, pp. 347-355, 2021, doi: 10.1123/jtpe.2021-0075.

[8] Y. Qian, "Badminton teaching modes and students' academic performance: Basis for teaching and learning approaches," Journal of Education and Educational Research, vol. 7, no. 2, pp. 144-148, 2024, doi: 10.54097/xexzxy92.

[9] X. Wang and S. Liu, "Research on the optimization of badminton teaching in colleges and universities under the background of "Internet+"," Contemporary Sports Technology, vol. 15, no. 10, pp. 31-34, 2025.

[10] Y. Ye and W. Tang, "Current Status and Countermeasures of Badminton Teaching in Universities under the Background of Integration of Physical Education and Education," Western Quality Education, vol. 10, no. 8, pp. 90-93, 2024.

[11] Y. Chen, "Research on the three-in-one composite badminton teaching model," Sports Science and Technology Bulletin, vol. 32, no. 11, pp. 182-184, 2024.

[12] M. Zeng, "Construction and Innovation Strategies of Badminton Teaching Methods in College Public Sports," Contemporary Sports Technology, vol. 14, no. 22, pp. 74-77, 2024.

[13] L. Chen, "A study on the influence of infrared application on sensory ability in badminton teaching," New Academic Horizons of Sichuan University of Commerce and Industry, vol. 9, no. 1, pp. 43-46, 2024.

[14] K. C. Lin, C. W. Ko, H. C. Hung, and N. S. Chen, "The effect of real-time pose recognition on badminton learning performance," Interactive Learning Environments, vol. 31, no. 8, pp. 4772-4786, 2023.

[15] M. Yan, "Research on tiered training method for cheerleading based on physical fitness differences," Contemporary Sports Technology, vol. 15, no. 9, pp. 30-32, 2025.