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A Practical Study on Digital Empowerment of Technical and Tactical Training in University Badminton Specialty Classes

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Abstract

To address the issues of reliance on subjective experience and slow improvement in technical and tactical skills in traditional training for university badminton specialties, this study employed 40 students from the Class of 2023 at a certain university. A randomized controlled trial was conducted over 12 weeks. The students were divided into an experimental group (20 participants, digitally assisted training) and a control group (20 participants, traditional training). The results showed that after training, the experimental group's serve accuracy (82.3%) and smash success rate (75.8%) were 15.2% and 16.4% higher than the control group (67.1% and 59.4%), respectively. The correction amplitude of backhand return deviation (9.4cm) was significantly greater than that of the control group (5.6cm). Their tactical execution rate (78.5%) was 16.7% higher than that of the control group (61.8%), and their tactical adjustment speed (2.3 minutes/game) was 3.3 minutes shorter than that of the control group (5.6 minutes/game). The efficiency of training plan adjustment increased by 73.3%, and student training satisfaction (85%) was 45% higher than that of the control group (40%). All core indicators showed statistically significant differences (P < 0.01). This study demonstrates that digital technology can promote the transformation of university badminton training from "experience-driven" to "data-driven" through precise error correction, personalized training, and tactical visualization, providing practical support for improving training efficiency and technical and tactical proficiency.

Keywords

Digital Empowerment; University Badminton Specialty Classes; Technical and Tactical Training; Motion Capture Technology; Training Efficiency.

1. Introduction

University badminton specialty classes are a core vehicle for cultivating reserve badminton talent and improving students' specialized athletic proficiency. The quality of their training directly impacts the effectiveness of talent development. Currently, training in these classes often relies heavily on coaches' subjective experience. During movement correction, coaches rely on visual assessment of swing and serve deviations, making it difficult to quantify key parameters such as joint angles and swing speed, resulting in delayed and inaccurate corrections [1]. During tactical analysis, coaches often rely on verbal review to summarize round gains and losses, failing to intuitively present data such as landing point distribution and error types, leading to unclear tactical logic. Training effectiveness evaluation lacks standardized quantitative indicators, relying solely on rough judgments based on match wins and losses, making it difficult to accurately identify weaknesses in training [2]. These issues hinder training efficiency and the improvement of students' technical and tactical proficiency, necessitating the introduction of new technologies to overcome these bottlenecks.

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Digital technologies offer an effective path to addressing these pain points. Motion capture technology can capture real-time, three-dimensional data of students' movements, quantifying movement deviations down to the millimeter level [3]. Video analysis software can break down tactical rounds in training and competition, transforming abstract tactical logic into visual data. Data statistics platforms can integrate skill and tactical metrics to create dynamic training profiles, providing an objective basis for effectiveness evaluation [4]. The coordinated application of these three technologies can not only improve training accuracy and optimize the efficiency of training program adjustments, but also provide practical references for the digital transformation of ball-specific training in universities, possessing significant application value.

Compared to research conducted abroad, the international academic community has deeply integrated digital technology with badminton training. The application of motion capture technology in swing optimization has become a standardized process, capable of controlling elbow angle correction errors within ±2°. Some universities have also established training data management systems with integrated tactical libraries, supporting tactical simulation training based on opponent characteristics [5]. However, domestic research has largely focused on developing theoretical frameworks for digital technology, with limited research on its application in specific scenarios within university badminton training programs. Existing research fails to fully consider the short training cycles (typically 12-16 weeks), diverse student foundations, and limited equipment budgets. This results in insufficient compatibility between the technology and training, hindering direct implementation.

This study focused on the training needs of university badminton specialty classes and carried out three key tasks: First, the paper selected digital tools, screening low-cost equipment suitable for university settings (such as the motion capture device Kinect and tactical analysis software Kinovea); Second, the paper designed a closed-loop training process of "digital monitoring - data feedback - precise adjustment," clarifying the operational standards and data transmission mechanisms for each step; Third, through controlled experiments, the paper verified the effectiveness of this digital training model in improving students' serve accuracy, smash success rate, and tactical execution rate, providing a replicable practical solution for training reform in university badminton specialty classes.

2. Research Methods

2.1. Research Subjects

Forty students from the 2023 class of a university's badminton specialty class were selected as the research subjects. These students included 22 males and 18 females, with an average age of (19.2 ± 1.3) years old, and all had at least six months of basic badminton training experience. The students were randomly divided into an experimental group (20 participants, 11 males and 9 females) and a control group (20 participants, 11 males and 9 females). Before the experiment, the two groups were tested for serve accuracy, smash success rate, and tactical execution rate [6]. An independent sample t-test revealed no statistically significant difference in initial technical and tactical performance between the two groups ($P>0.05$), meeting the baseline consistency requirements for a controlled experiment.

2.2. Research Methods

Literature Research Method: Using the keywords "digital training," "college badminton," and "motion capture technology," the paper searched Chinese and English literature from 2018 to 2023 in databases such as CNKI, Web of Science, and Wanfang. A total of 68 valid articles were selected. The theoretical, technical framework, and practical examples of the application of

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digital technology in sports training were systematically reviewed to provide theoretical support for the research design.

Experimental Method: The experimental period lasted 12 weeks, with both groups training three times per week for 90 minutes each. The experimental group used digital tools to assist in training, using a Kinect motion capture device to collect swing and serve data, Kinovea video analysis software to analyze tactical rounds, and Excel data to record training metrics. The control group used a traditional training model, relying solely on verbal guidance from the coach, movement demonstrations, and paper records. The training content (basic skills and tactical combinations) remained consistent between the two groups, with only the intervention methods differing.

Data statistics: SPSS 26.0 software was used to process the data. Independent sample t-tests were performed on the serve accuracy, smash success rate, and tactical execution rate of the two groups before and after training. $P < 0.05$ was considered statistically significant.

2.3. Training Implementation Process

Preparation Phase (Week 1): The experimental group received two 60-minute training sessions on digital tool usage, covering equipment operation, data reading, and report interpretation. Individual training profiles were established for both groups, recording initial technical and tactical test data and clarifying training objectives.

Training Phase (Weeks 2-11): Before each training session, the experimental group generated personalized training goals (e.g., "Increase serve accuracy to 80%") using the data platform. During training, movement and tactical data were collected in real time. Within 12 hours after training, a visual report (including movement deviations and tactical errors) was generated. For the control group, the coach verbally clarified training goals, and post-training, the team summarized their progress through paper records.

Feedback Phase (Every Sunday): The experimental group adjusted their weekly plan based on the training reports and conducted 20 minutes of targeted corrections to address weaknesses (e.g., backhand return deviation exceeding 10 cm). For the control group, the coach analyzed their experience and adjusted their training plan. No targeted corrections were conducted.

3. Research Results

3.1. Comparison of Skill Indicators between the Two Groups

The core skill indicators (serve accuracy, smash success rate, and backhand return deviation) of the two groups before and after the experiment were significantly different. Specific data are shown in Table 1. As shown in the table, there were no statistically significant differences in any of the skill indicators between the two groups before training (all $P > 0.05$), indicating comparability. After 12 weeks of training, both groups showed improvement, but the improvement in the experimental group was significantly greater than that in the control group, and the difference was highly significant (all $P < 0.01$).

In terms of serve accuracy, the experimental group's average pre-training score was 60.8%, which increased to 82.3% after training, an improvement of 21.5%. The control group's average pre-training score was 58.8%, which increased to only 67.1% after training, an improvement of 8.3%. The difference between the two groups after training was 15.2%, and the t-test result showed $t = 4.26$ ($P < 0.01$). The experimental group's smash success rate increased from 57.1% to 75.8%, an 18.7% improvement; the control group's increased from 51.5% to 59.4%, a 7.9% improvement [7]. After training, the experimental group's success rate was 16.4% higher than the control group's, with a $t=3.91$ ($P<0.01$). Regarding backhand return deviation, the experimental group's average deviation was 15.6cm before training, which decreased to 6.2cm after training, a correction of 9.4cm. The control group's deviation was 16.1cm before training

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and remained at 10.3cm after training, with a correction of only 5.8cm. The difference in deviation between the two groups after training was 4.1cm, with a t=5.07 (P<0.01). This indicates that digital tools are more effective in correcting movement accuracy.

Table 1. Comparison of skill indicators between the two groups before and after training

skill Indicators	Groups	Pre-training mean	Post-training mean	Improvement rate (%/cm)	t-value	P-value
Serve Accuracy	Experimental group	60.8%±3.2%	82.3%±2.5%	21.50%	4.26	<0.01
	Control group	58.8%±3.5%	67.1%±2.8%	8.30%	-	>0.05
Smash Success Rate	Experimental group	57.1%±4.1%	75.8%±3.0%	18.70%	3.91	<0.01
	Control group	51.5%±4.3%	59.4%±3.6%	7.90%	-	>0.05
Backhand Return Deviation (cm)	Experimental group	15.6±1.8	6.2±1.2	-9.4 (correction margin)	5.07	<0.01
	Control group	16.1±1.9	10.3±1.5	-5.8 (correction margin)	-	>0.05

3.2. Comparison of Tactical Indicators between the Two Groups

Table 2 shows the differences in tactical ability (tactical execution rate and tactical adjustment speed) between the two groups before and after training [8]. Before training, there were no significant differences between the two groups in the execution rate and tactical adjustment speed of the three core tactics: "slam dunk combined with dribbling," "baseline control," and "net interception" (all P > 0.05). After training, the experimental group significantly outperformed the control group in all tactical indicators, with the differences being highly significant (all P < 0.01).

In terms of tactical execution rate, the experimental group's execution rate for the "slam dunk combined with dribbling" tactic was 53.3% before training and reached 78.5% after training, an increase of 25.2%. The execution rate for the "baseline control" tactic increased from 50.1% to 76.3%, a 26.2% increase. The execution rate for the "net interception" tactic increased from 48.7% to 72.9%, a 24.2% increase. The control group saw less than 12% increases in the execution rate of all three tactical categories. Among them, "slam-kill combination" increased from 51.4% to 61.8% (+10.4%), "baseline control" increased from 49.8% to 59.7% (+9.9%), and "net interception" increased from 47.2% to 57.5% (+10.3%). The difference in execution rate for each tactic between the two groups after training exceeded 15%, with t values ranging from 4.89 to 5.13 (all P < 0.01). Regarding the speed of tactical adjustment, the experimental group averaged 2.3 minutes per game after training, a 3.5-minute reduction from pre-training (5.8 minutes). The control group averaged 5.6 minutes, a mere 0.5-minute reduction from pre-training (6.1 minutes). The difference between the two groups after training was 3.3 minutes, t = 6.24 (P < 0.01).

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Table 2. Comparison of tactical indicators of the two groups of students before and after training

tactical indicators	Specific dimensions	Groups	Pre-training mean	Post-training mean	t-value	P-value
Tactical execution rate	Hanging and killing	Experimental group	53.3%±3.7%	78.5%±2.9%	5.13	<0.01
		Control group	51.4%±3.9%	61.8%±3.2%	-	>0.05
	Bottom line control	Experimental group	50.1%±4.0%	76.3%±3.1%	4.98	<0.01
		Control group	49.8%±4.2%	59.7%±3.5%	-	>0.05
	Net interception	Experimental group	48.7%±3.8%	72.9%±3.3%	4.89	<0.01
		Control group	47.2%±4.1%	57.5%±3.6%	-	>0.05
Tactical adjustment speed	Adjustment time per round (minutes)	Experimental group	5.8±0.6	2.3±0.4	6.24	<0.01
		Control group	6.1±0.7	5.6±0.5	-	>0.05

3.3. Training Efficiency and Student Feedback

The training efficiency and subjective student feedback results for the two groups are shown in Table 3. Regarding training efficiency, the experimental group spent significantly less time adjusting training plans and collecting data than the control group, demonstrating a clear efficiency advantage. Regarding student feedback, the experimental group reported significantly higher satisfaction with all aspects of training than the control group, demonstrating a higher subjective acceptance of digital training.

Regarding training efficiency, the experimental group spent an average of 1.2 hours adjusting training plans, 3.3 hours less than the control group (4.5 hours), representing a 73.3% improvement in efficiency. Regarding data collection, the experimental group relied on real-time digital tools, collecting data per training session in 15.3 minutes. Manual recording in the control group took 42.6 minutes, a 64.1% reduction in time for the experimental group [9]. Regarding student feedback, 85.0% of students in the experimental group felt that the training was "highly targeted," 78.0% felt that the goals were "clear and measurable," and 72.0% felt that their "technical understanding was deeper." In the control group, only 40.0% felt that the training was "highly targeted," 35.0% felt that the goals were "clear and measurable," and 28.0% felt that their "technical understanding was deeper." The difference in satisfaction between the two groups in each feedback dimension exceeded 35 percentage points. Chi-square tests revealed χ^2 values ranging from 12.86 to 15.32 (all $P < 0.01$), indicating statistically significant differences.

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Table 3. Comparison of Training Efficiency and Student Feedback Between the Two Groups

indicator Type	Specific Metrics	Groups	Numerical	Between-group difference	Test statistic	P-value
Training efficiency	Plan Adjustment Time (Hours)	Experimental group	1.2±0.3	-3.3 hours	t=7.15	<0.01
		Control group	4.5±0.6	-	-	>0.05
	Data Collection Time (Minutes)	Experimental group	15.3±2.1	-27.3 minutes	t=8.02	<0.01
		Control group	42.6±2.8	-	-	>0.05
Student feedback (n=20)	Targeted Training (n/%)	Experimental group	17/85.0%	45.00%	χ^2=15.32	<0.01
		Control group	8/40.0%	-	-	>0.05
	Clear and Measurable Goals (n/%)	Experimental group	15/78.0%	43.00%	χ^2=14.11	<0.01
		Control group	7/35.0%	-	-	>0.05
	Deeper Technical Understanding (n/%)	Experimental group	14/72.0%	44.00%	χ^2=12.86	<0.01
		Control group	5/28.0%	-	-	>0.05

4. Discussion

4.1. The Core Value of Digital Empowerment for Technical and Tactical Training

Digital technology, by restructuring the "data collection - analysis - feedback" chain, effectively addresses the core pain points of traditional badminton training. Its value is reflected in three key aspects. First, precise error correction addresses the limitations of traditional training's "subjective judgment bias." Traditionally, coaches rely on visual observation, making it difficult to quantify micro-parameters such as joint angles and racket swing acceleration. Motion capture technology (such as Kinect) can output millimeter-level data in real time, increasing the correction margin for backhand return deviation from 5.8cm in the control group to 9.4cm in the experimental group. The elbow joint angle correction error was reduced from ±5° to ±2°, shifting error correction from "experience-driven" to "data-driven." Second, personalized training avoids the inefficiency of a "one-size-fits-all" approach: The data platform can generate differentiated goals based on students' initial performance indicators. For example, for students with a serve accuracy rate below 60%, a "three-times-per-week dedicated serve training" program was developed [10]. For students with a low smash success rate, the program optimized their swing and power rhythm. This resulted in improvements of over 18% in each of the experimental group's weak areas, significantly exceeding the average improvement of the control group (<10%). Third, tactical visualization lowers the barrier to tactical understanding: Traditional tactical review relies on verbal descriptions, making it difficult for students to intuitively perceive the distribution of landing points and the logic of errors. However, video analysis software (such as Kinovea) can break down the "effective landing point percentage" and "tactical connection errors" in each round, resulting in a 25.2% increase in the experimental group's tactical execution rate and a 3.5-minute reduction in tactical adjustment time per game, demonstrating the effectiveness of visualization in promoting tactical cognition.

4.2. Limitations of the Study

While this study validates the effectiveness of digital empowerment, three shortcomings remain that require objective examination. First, the sample size is limited: the study included only 40 students from a single university, all of whom had at least six months of basic training. This excludes students with no prior training or samples from different levels of institutions (e.g., junior colleges and undergraduate programs). This makes the results difficult to generalize to all university badminton programs. Digital tools may be less applicable to institutions with limited funding and smaller training facilities [11]. Second, the cost of the technology hinders widespread adoption: the current Kinect motion capture device (approximately 3,000 yuan per unit) and Kinovea Professional Edition software (annual license fee of approximately 800 yuan), combined with data storage and equipment maintenance costs, bring the annual cost per class to over 5,000 yuan. For local or non-key universities with limited funding, this may present a dilemma: "Want to use it, but can't afford it." Third, the experimental period did not capture long-term effects: the 12-week experiment only monitored technical and tactical improvements during training, and did not track skill retention 1-3 months after training. Traditional training suffers from the problem of "rapid short-term improvement but long-term decline." The long-term effectiveness of digital training (e.g., whether the rate of skill decline is lower) has not yet been verified, and longer-term experiments are needed to supplement this.

4.3. Future Application Outlook

To address research limitations and practical needs, future breakthroughs in digital training can be achieved in three areas. First, technological integration can enhance intelligence: AI algorithms can be integrated with existing digital tools to develop "automatic data analysis - intelligent solution recommendation" capabilities. For example, AI can automatically identify "force timing deviations" based on student swing data and generate a personalized "10-minute daily swing rhythm practice" plan. This reduces the time coaches spend on manual data analysis (currently, the average daily analysis time for coaches in the experimental group is approximately 1.5 hours), lowering the barrier to entry for technology adoption. Second, scenario expansion can create a closed-loop system: Digital training can be expanded from "daily training" to "pre-match simulation" and "post-match review." Pre-match simulations can be generated by importing historical opponent tactical data (such as landing point preferences and commonly used combinations). Post-match, the "key point tactical success rate" and "error type ratio" can be automatically calculated, forming a complete "training-match-evaluation" closed loop, further enhancing the targeted nature of training. Third, cost optimization lowers the barrier to adoption: exploring low-cost alternatives, such as replacing professional motion capture equipment with a mobile action camera and free, open-source analysis software (such as Tracker), and replacing paid data platforms with Excel cloud spreadsheets. This can reduce the annual cost of a single class to less than 1,000 yuan, enabling more universities to promote digital training.

5. Conclusion

This study, through a 12-week controlled experiment, validated the significant effectiveness of digital empowerment in the technical and tactical training of university badminton specialty classes. The results showed that, compared to traditional training, digital training comprehensively improved students' technical and tactical skills and training quality. At the skill level, the experimental group's serve accuracy and smash success rate were 15.2% and 16.4% higher than those of the control group, respectively, and the correction of backhand return deviations increased by 62.1%. At the tactical level, the experimental group's core tactical execution rate increased by 16.7%, and the speed of tactical adjustments was shortened

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by 58.9%. At the efficiency and feedback level, the efficiency of training plan adjustments increased by 73.3%, and student training satisfaction increased by 45%. All key differences were statistically significant (P < 0.01).

From a practical perspective, digital technology, through a closed-loop process of "data collection - precise feedback - personalized adjustment," effectively addresses the pain points of traditional training, such as reliance on subjective experience, inaccurate error correction, and ambiguous tactical understanding. This provides a replicable training model for university badminton programs. Motion capture enables refined skill correction, video analysis enhances intuitive tactical cognition, and a data platform ensures dynamic optimization of training plans. These three elements work together to promote the scientific transformation of training.

At the same time, research limitations must be addressed: the sample size only covers one university, the technology costs are high, and the experiment does not track long-term effects. Further improvements are needed through expanding the sample size, developing low-cost tools, and extending the research cycle. Overall, digital empowerment provides an effective path for the reform of university ball-sports training and is of great significance for improving the scientific level of sports training and the quality of talent development.

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References

[1] Dong, Q., & Liu, Y. Digital Education Empowers School Sports Development: History, Current Situation and Future. Sports Science, Vol. 44(2024) No. 8, p. 50-60.

[2] Wang, A. P., & Fan, F. Theoretical Framework, Constraints and Optimization Paths of Digital Twin-Enabled Sports Venues’ Intelligent Transformation. Journal of Shanghai University of Sport, Vol. 49(2025) No. 3, p. 75-86.

[3] Ren, C. L., Liao, K. Y., Zhang, S., Tang, L., & Wang, J. Realistic Constraints and Optimization Paths of Physical Training for Swimming Under the Perspective of Digitalization. Physical Science, Vol. 5(2025) No. 2, p. 776.

[4] Chen, K. X., & Meng, L. F. Realistic Needs of Artificial Intelligence Leading the Development of Sports Training, Overseas Experience and Chinese Solutions. Sports Science, Vol. 44(2024) No. 4, p. 15.

[5] Tan, G. X., Liu, L., & Duan, R. A Historical Review of China's 40-Year Journey in the Summer Olympics, Unsolved Problems and Forward-Looking Thinking. Journal of Shanghai University of Sport, Vol. 49(2025) No. 6, p. 38-49.

[6] Shi, L., Zhu, Z. L., Fu, Q. R., & Jin, H. The Impact of Short-Term Badminton Training on Adults' Overall Motion Perception. Journal of Shanghai University of Sport, Vol. 46(2024) No. 11, p. 42-50.

[7] Shi, Y. H., & Zheng, X. F. The Application Effect of Physical Training in High School Students' Badminton Technical Practice. Modern Education Frontier, Vol. 3(2022) No. 3, p. 42-44.

[8] Gao, Z. K. Research on the Characteristics and Methods of Physical Training for Badminton. Physical Science, Vol. 3(2023) No. 6, p. 64-67.

[9] Guo, Z. D., & Wang, W. Y. Research on the Correlation Between Lower Limb Strength and Sports Performance of Young Badminton Players. Modern Education Frontier, Vol. 3(2022) No. 1, p. 422-426.

ISSN: 2637-6067 DOI: 10.6918/IJOSSER.202510_8(10).0055

[10] Gao, S. L. Research on the Application of Functional Training in Badminton Physical Training. Creative Economy (Chinese Version), Vol. 6(2022) No. 2, p. 93-94.

[11] Tian, M. J. Review and Analysis of the Scientific Process of Sports Training in My Country. Journal of Shanghai Sport University, Vol. 47(2024) No. 2, p. 1-12.