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Article

A Study on the Teaching Effectiveness of Computer Simulation Technology in Assisting Volleyball Tactical Training and the Improvement of Athletes' Cognitive Abilities

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Abstract: This paper applies computer-assisted technology to the field of volleyball instruction, designing a CAI system for volleyball tactical training. Relevant experiments were then designed to evaluate the teaching effectiveness of the CAI-based volleyball tactical training method and its impact on athletes' cognitive abilities. There were no significant differences in basic technical skills and tactical combinations between the experimental group and the control group in the pre-test. After the experiment, significant differences emerged between the two groups in basic technical skills and tactical combinations ($P < 0.05$). The experimental group scored higher than the control group by 4.01, 2.60, 3.30, 3.60, 3.22, 3.82, 4.42, 3.76, and 4.08 points across nine sub-dimensions. The cognitive abilities of athletes in both the experimental and control groups remained at similar levels in the pre-test. After the experiment, the experimental group outperformed the control group by 6.68, 7.58, 9.76, and 9.20 points in four sub-dimensions of cognitive ability, with a significance level of less than 0.05. This indicates that the CAI-based volleyball tactical training method used in this study has good teaching effects and can significantly improve athletes' cognitive abilities.

Keywords: computer-assisted; CAI system design; volleyball tactical training; teaching effects

1. Introduction

Volleyball is a highly technical sport that requires excellent physical fitness and a solid technical foundation [1-2]. When conducting volleyball training and instruction, how to enhance its effectiveness so that athletes can better master techniques, improve physical fitness, and enhance cognitive abilities is an important issue [3-4].

Tactical training is an important method for improving the overall quality of volleyball athletes. It requires a balance between individual skills and team collaboration. Effective tactics can give a team the upper hand in competitions. This training method requires understanding each player's characteristics beforehand, assigning positions and tasks based on their abilities, and maximizing each individual's strengths [5-8]. However, traditional training methods require significant time and effort, with slow and inconsistent results. To effectively enhance teaching outcomes and athletes' cognitive abilities, the application of computer simulation technology has garnered widespread attention [9-12]. Computer simulation technology is a technique that uses computers to simulate the behavior and operation of various systems [13]. It encompasses multiple aspects such as mathematical models, computational methods, and data processing, and can be used to simulate and study the behavior and operation of various systems, including physical systems, chemical systems, logistics systems, transportation systems, and human-computer interaction systems [14-17]. In assisting volleyball tactical training, computer simulation technology can use virtual reality technology to simulate and generate virtual three-dimensional environments and scenarios, enabling athletes to interact directly with the virtual environment for training. This method is not restricted by location or time, significantly enhancing the teaching effectiveness of volleyball tactical training and athletes' cognitive abilities [18-21].

Reference [22] introduces the sport of volleyball and China's investment in volleyball training, reveals the current trend of integrating computer technology with volleyball training methods, and finally explores the application of computer technology in the field of volleyball training. Reference [23] based on research on volleyball athletes of different levels reveals that the application of machine learning and digital information technology in volleyball can effectively improve athletes' athletic abilities. Literature [24] examines the application of digital technology in volleyball training and analyzes its promotional effects on improving athletes' physical readiness, technical and tactical performance, and injury prevention, emphasizing the importance of digital integration in modern training. Literature [25] leverages virtual reality technology and its key features to deeply integrate volleyball tactical movements and athletic skills, aiming to achieve an effective combination of volleyball training and virtual reality technology to assist in volleyball learning. Literature [26] aims to examine the effectiveness of 3D modeling and motion capture technology in sports training, emphasizing that it effectively improves training outcomes and encourages athletes to engage in proper movement. Literature [27] emphasizes that flexibility, coordination, and strength are essential foundational conditions for volleyball performance. Excellent volleyball performance relies on athletes' comprehensive physical, physiological, and technical qualities, and the study elucidates the positive impacts of VR, 3D modeling, and motion capture technologies on volleyball training. Literature [28] points out that traditional training methods are not conducive to improving volleyball skills and compares the application of augmented reality technology in volleyball training, revealing that augmented reality can effectively improve volleyball training and teaching outcomes. The above studies have verified the effectiveness of computer information technology in teaching and sports training by researching the application of digital information technology, 3D modeling, VR technology, and motion capture technology in volleyball training.

The author attempted to introduce computer simulation technology into volleyball tactical training instruction, constructing a CAI system for volleyball tactical training. Based on a thorough analysis of system requirements, the system was designed using Visual Studio, C#, and an Access database. Based on the basic circumstances of volleyball training, the CAI-based volleyball tactical training content in this paper primarily focuses on single-player blocking defense formations, double-player blocking defense formations, and triple-player blocking defense formations. Pre- and post-experiment tests were conducted on the experimental subjects to assess their basic technical skills, tactical combinations, and cognitive abilities. The pre- and post-test results were compared and analyzed within and between groups to validate the effectiveness of the computer-assisted volleyball tactical training method proposed in this paper.

2. CAI-based volleyball tactical training design

2.1. CAI

Computer-Assisted Instruction (CAI), in a broad sense, primarily refers to the widespread application of computer technology in the field of education [29], encompassing various ways of utilizing computers in teaching, research, and management. In a narrow sense, CAI refers to a teaching method where teachers use computers as teaching media to provide a teaching platform environment, and students acquire knowledge and learn skills through interactive dialogue with the computer within this platform. Computer-assisted education consists of two main components: CAI and CMI (Computer-Mediated Instruction), with CAI being the most important part. Additionally, it includes other aspects such as computer-assisted administrative management and computer-based instruction.

CAI refers to the use of computer technology as a medium and carrier for teaching, achieving educational objectives through interactive activities between students and computer-based software. The emergence of CAI represents a significant innovation in the field of computer education, playing a crucial role in modernizing teaching strategies and methods across different disciplines, breaking away from traditional educational concepts, and promoting educational reform.

Due to the high difficulty of mastering basic volleyball techniques and the complexity and variability of tactical strategies, traditional volleyball training often requires significant effort to repeatedly correct incorrect movements and formations, thereby hindering overall skill improvement. With the development of this new training model, its application in volleyball training has become increasingly widespread.

2.2. Design of CAI System for Volleyball Training

2.2.1. System Requirements Analysis

Volleyball training design is the planning process for volleyball training. Coaches must start from the objectives of volleyball training and the pathways to achieving those objectives, conducting a scientific and comprehensive analysis of all factors involved in the training process. This involves designing appropriate training progressions, formulating reasonable training strategies, and selecting suitable training methods and techniques. Therefore, scientific volleyball training design is a prerequisite for improving the quality of volleyball training, and the analysis of training design requirements is the key.

(1) Analysis of athletes' needs and developmental requirements

Only through an objective analysis of athletes' training needs and developmental requirements can reasonable sports training objectives be established and scientific sports training design be conducted, i.e., clarifying why athletes train.

(2) Analysis of training content

This involves coaches determining what athletes should train based on their training and developmental needs.

(3) Analysis of athletes

Effective sports training design must analyze athletes' preparatory state before training, including their physical and mental characteristics and foundational skills in specific areas.

(4) Design of Sports Training Goals

Clear and specific training goals serve as the guiding principles for formulating sports training strategies and selecting training media, and also provide the basis for evaluating training effectiveness.

(5) Design of Training Strategies

Sports training strategies primarily involve studying the types and structure of training programs, the sequence and rhythm of training, teaching activities, teaching and learning methods, forms of training, spatial and temporal arrangements for training, and implementation strategies for training activities.

(6) Design of Training Media

When designing training, training media should be selected based on the principle of "economic efficiency." Training content and methods should be converted into specific, detailed, and operational implementation plans in the form of printed or audiovisual materials.

(7) Design of the Training Process

The interrelationships between various elements can be expressed concisely using flowcharts.

(8) Design of Training Evaluation

The outcomes of sports training design should be evaluated.

2.2.2. Technical Basis for System Design

(1) Database Technology

Database technology is a core technology of information systems and a computer-assisted method for managing data. It studies how to organize and store data, as well as how to efficiently retrieve and process data. It involves researching the basic theories and implementation methods related to database structure, storage, design, management, and application, and utilizing these theories to process, analyze, and understand data within databases.

The research and management focus of database technology is data, so the specific content it covers primarily includes: establishing corresponding databases and data warehouses according to specified structures through the unified organization and management of data. Using database management systems and data mining systems to design data management and data mining application systems capable of performing various functions such as adding, modifying, deleting, processing, analyzing, understanding, reporting, and printing data within databases. And ultimately achieving data processing, analysis, and understanding through application management systems.

(2) Visual Studio Development Environment

Microsoft Visual Studio, abbreviated as VS, is a series of development toolkits produced by Microsoft Corporation. VS is a comprehensive development toolset that includes most of the tools required throughout the software lifecycle, such as UML tools, code management tools, and integrated development environments (IDEs). The target code written using VS is compatible with all platforms supported by Microsoft.

(3) C# Programming Language Development Technology

Visual C# is an object-oriented programming language developed by Microsoft and is an important component of the Microsoft development environment. It is designed to generate various applications that run on the platform. C# is simple, powerful, type-safe, and object-oriented. With its many innovations, it achieves rapid application development while maintaining the expressive power and elegance of the C-style language.

The seamless integration of Visual Studio, C#, and Access databases enables the design of user-friendly interfaces for user operations, as well as convenient information querying and updating. Users do not need specialized computer knowledge or database expertise; they can obtain the required information through interface buttons, which are simple, clear, and visually appealing.

(4) B/S (Browser/Server) Architecture Model

This system adopts a network-based B/S architecture model. The designed system is deployed on the server, which assigns a URL. Users can log in to the system website by clicking on the generated URL. Users can log in as administrators to update database information, and ordinary users can view the updated information on their own hosts, aligning with the system's original intent of resource sharing and providing users with convenient and efficient information services. However, depending on user needs, if users require access beyond network restrictions, the system can be modified to a desktop system mode.

The B/S structure is a network-based architecture [30]. It emerged with the rise of Internet technology as an extension of the C/S model. In this architecture, users access the system through a browser or other web-based interface. The primary advantage of the B/S model is its simplicity in operation and maintenance, enabling different users to access and operate shared data from various locations using different connection methods. This aligns with the functional requirements of this system, and adopting a web-based form better facilitates the system's functionality.

2.2.3. Volleyball Tactics Teaching Content

Based on training requirements, the system's training content primarily covers three scenarios: single-player blocking defense formations, double-player blocking defense formations, and triple-player blocking defense formations.

(1) Single-player blocking defense formation

The single-player blocking "1-2-3" defense formation at position 3 is shown in Figure 1. When the opposing team's position 3 performs a quick attack, the corresponding blocking player on our team performs a single-player block. The other two players not participating in the block strive to retreat to defend against the spike, while the back-row players compress the defensive area forward. Among them, the players at positions 1 and 5 primarily defend the wing positions on both sides, while position 6 presses forward to defend the central zone, forming the "1-2-3" defensive formation. The reason for compressing the defensive area forward is that after the fast ball passes through the block, the trajectory is short, and the landing points are primarily in the central zone and the wing areas.

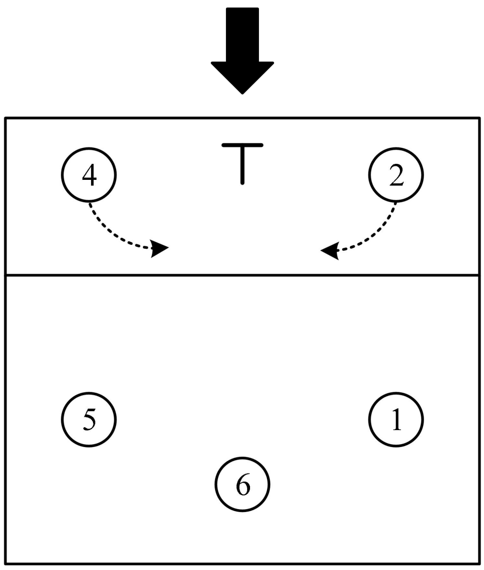

Figure 1. NO.3 single block "123" defensive formation.

(2) Double Blocking Defense Formation

1) "Side Follow-Up" Defense Formation

The "Side Follow-Up" defense formation involves the back-row side player on the same side as the opposing spiker following up to defend against the spike. The player in position 6 should adjust their positioning based on the spike trajectory. Special attention should be paid to the open space behind the following-up defender. The front-row players not blocking should retreat to defend against the small diagonal line, while the remaining players primarily defend against the central diagonal line.

2) “Center Follow-Up” Defense Formation

The “Center Follow-Up” defense formation is still commonly used in matches involving beginner and intermediate-level teams, but high-level teams rarely use it. Regardless of which position the opponent attacks from, it is the responsibility of the back-row players to follow up and defend against the spike by “filling the center.” During the initial learning process, the player in position 6 is typically assigned to follow up and defend against the spike by “filling the center.”

(3) Three-Person Blocking Defense Formation

The three-person block 3-2-1 defensive formation is shown in Figure 2. When the opponent launches a strong attack from the 4th position, our front-row players form a three-person block, with the back-row defender on the same side as the attacker primarily defending the straight line and secondarily defending against the lob. The 4th position player presses the bottom and swings to assist, while the other back-row player defends the diagonal line.

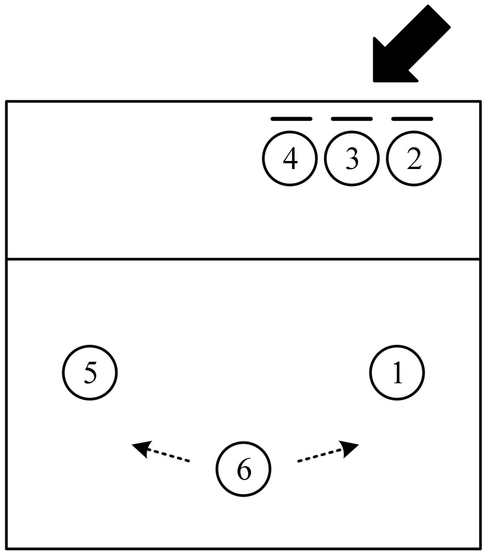

Figure 2. Three people block “321” defensive formation.

3. Analysis of the effectiveness of supplementary training

3.1. Analysis of basic techniques and tactical combinations

To investigate the teaching effectiveness of computer-assisted volleyball tactical training methods, the author selected 40 students from the volleyball team of W University as experimental subjects. All students were randomly divided into two groups (experimental group and control group). Different methods were used in the volleyball tactical training of the two groups. The experimental group used the CAI volleyball tactical training method described in this paper, while the control group used traditional training methods. By comparing the differences and changes in basic techniques (passing, setting, spiking, serving) and tactical combinations (team formation, offensive formations, receiving serve defense tactics, receiving spike defense tactics, receiving block return defense tactics) between the two groups before and after the experiment, the effectiveness of the computer-assisted volleyball tactical training method proposed in this paper was evaluated.

The pre-experiment test results for basic techniques and tactical combinations for the experimental and control groups are shown in Table 1. As shown in Table 1, there were no significant differences in scores between the experimental and control groups for each measurement indicator of basic techniques and tactical combinations before the experiment. The score differences for each indicator did not exceed 1 point, and the P-values were all greater than 0.05. This indicates that the performance of both groups before the experiment was suitable for subsequent experiments.

Table 1. Pre-test basic skills and tactical combination of experimental and control group.

	Group	Number	Mean	SD	T	P
Ball passing	Experimental	20	5.19	2.03	0.656	0.764

	Control	20	5.03	2.37		
Ball digging	Experimental	20	5.44	2.02	-0.423	0.752
	Control	20	5.55	1.34		
Ball smashing	Experimental	20	4.98	1.29	-0.584	0.766
	Control	20	5.14	2.47		
Ball serving	Experimental	20	5.47	1.98	-0.635	0.695
	Control	20	5.64	1.53		
Squad equipping	Experimental	20	6.06	1.99	0.426	0.611
	Control	20	5.95	2.27		
Offensive formation	Experimental	20	5.53	1.95	0.598	0.609
	Control	20	5.33	2.23		
Receiving & serving defensive tactic	Experimental	20	5.87	2.09	0.896	0.601
	Control	20	5.14	2.12		
Receiving & smashing defensive tactic	Experimental	20	4.96	2.26	-0.261	0.696
	Control	20	5.02	2.51		
Receiving & blocking defensive tactic	Experimental	20	5.34	1.29	-0.724	0.769
	Control	20	5.57	1.49		

After the experiment, the basic technical and tactical combinations of the experimental group and the control group were measured again, and an independent samples t-test was conducted. The results are shown in Table 2. As shown in Table 2, after the experiment, the experimental group outperformed the control group in all nine measurement dimensions of basic technical and tactical combinations. The score differences between the two groups in passing, setting, spiking, serving, team composition, offensive formations, receiving serve defense tactics, receiving spike defense tactics, and receiving block defense tactics expanded from less than 1 point to 4.01, 2.60, 3.30, 3.60, 3.22, 3.82, 4.42, 3.76, and 4.08 points, respectively. Additionally, the post-test results for all dimensions in both groups showed statistical significance at the 0.05 level.

Table 2. Post-test basic skills and tactical combination of experimental and control group.

	Group	Number	Mean	SD	T	P
Ball passing	Experimental	20	9.79	3.95	5.895	0.000
	Control	20	5.78	2.58		
Ball digging	Experimental	20	8.76	3.33	1.585	0.004
	Control	20	6.16	1.84		
Ball smashing	Experimental	20	8.52	4.12	3.574	0.003
	Control	20	5.22	2.27		
Ball serving	Experimental	20	9.58	3.82	3.968	0.002
	Control	20	5.98	2.31		
Squad equipping	Experimental	20	9.26	4.03	3.316	0.003
	Control	20	6.04	2.17		
Offensive formation	Experimental	20	9.59	4.46	4.152	0.000
	Control	20	5.77	2.24		
Receiving & serving defensive tactic	Experimental	20	9.59	3.73	6.245	0.000
	Control	20	5.17	2.15		
Receiving & smashing defensive tactic	Experimental	20	9.89	4.46	4.087	0.001
	Control	20	6.13	2.03		
Receiving & blocking defensive tactic	Experimental	20	9.87	3.43	5.974	0.000
	Control	20	5.79	1.23		

The pre- and post-test results of basic techniques and tactical combinations for the experimental group and control group were validated. The validation results within each group are shown in Tables 3 and 4, respectively. As shown in Table 3, the experimental group's basic techniques and tactical combinations improved significantly after the experiment, with an average increase of approximately 4 points across all dimensions, and all P-values were significantly less than 0.05. As shown in Table 4, the control group's basic technical and tactical combinations also improved to some extent after the experiment, but the improvement was limited, and the P-values for all dimensions were greater than 0.05. This indicates that the CAI-based volleyball tactical training method used in this study has a significant positive effect on students' basic technical and tactical combinations.

Table 3. Pre-test and post-test basic skills and tactical combination of experimental group.

	Pre/Post-test	Number	Mean	SD	T	P
Ball passing	Pre-test	20	5.19	2.03	-6.275	0.000
	Post-test	20	9.79	3.95		
Ball digging	Pre-test	20	5.44	2.02	-3.852	0.002
	Post-test	20	8.76	3.33		
Ball smashing	Pre-test	20	4.98	1.29	-4.276	0.001
	Post-test	20	8.52	4.12		
Ball serving	Pre-test	20	5.47	1.98	-5.584	0.000
	Post-test	20	9.58	3.82		
Squad equipping	Pre-test	20	6.06	1.99	-3.085	0.003
	Post-test	20	9.26	4.03		
Offensive formation	Pre-test	20	5.53	1.95	-5.367	0.000
	Post-test	20	9.59	4.46		
Receiving & serving defensive tactic	Pre-test	20	5.87	2.09	-4.582	0.001
	Post-test	20	9.59	3.73		
Receiving & smashing defensive tactic	Pre-test	20	4.96	2.26	-6.415	0.000
	Post-test	20	9.89	4.46		
Receiving & blocking defensive tactic	Pre-test	20	5.34	1.29	-6.178	0.000
	Post-test	20	9.87	3.43		

Table 4. Pre-test and post-test basic skills and tactical combination of control group.

	Pre/Post-test	Number	Mean	SD	T	P
Ball passing	Pre-test	20	5.03	2.37	-0.825	0.685
	Post-test	20	5.78	2.58		
Ball digging	Pre-test	20	5.55	1.34	-0.647	0.715
	Post-test	20	6.16	1.84		
Ball smashing	Pre-test	20	5.14	2.47	-0.264	0.649
	Post-test	20	5.22	2.27		
Ball serving	Pre-test	20	5.64	1.53	-0.527	0.583
	Post-test	20	5.98	2.31		
Squad equipping	Pre-test	20	5.95	2.27	-0.315	0.475
	Post-test	20	6.04	2.17		
Offensive formation	Pre-test	20	5.33	2.23	-0.528	0.641
	Post-test	20	5.77	2.24		
Receiving & serving defensive tactic	Pre-test	20	5.14	2.12	-0.174	0.593
	Post-test	20	5.17	2.15		
Receiving & smashing defensive tactic	Pre-test	20	5.02	2.51	-0.926	0.578
	Post-test	20	6.13	2.03		
Receiving & blocking defensive tactic	Pre-test	20	5.57	1.49	-0.415	0.782
	Post-test	20	5.79	1.23		

3.2. Analysis of athletes' cognitive abilities

In addition to investigating the teaching effectiveness of the computer-assisted volleyball tactical training method described in this paper, the author also considered changes in athletes' cognitive abilities. This section employs the same methodology as the previous section to measure cognitive abilities in the experimental and control groups, focusing on four aspects: audiovisual reaction ability, understanding and analytical ability, comprehensive problem-solving ability, and summary and application ability.

The results of the pre-test comparison analysis of the cognitive ability sub-dimensions between the experimental group and the control group are shown in Table 5, and the results of the post-test comparison analysis are shown in Table 6. As shown in Tables 5 and 6, prior to the experiment, the differences in audiovisual reaction ability, understanding and analytical ability, comprehensive problem-solving ability, and summary and application ability between the experimental group and the control group were small, and the P-values for all dimensions were greater than 0.05, indicating no significant differences in cognitive abilities between the two groups. After the experiment, the athletes in the experimental group scored 6.68, 7.58, 9.76, and 9.20 points higher than those in the control group in terms of auditory-visual reaction ability, comprehension and analysis ability, comprehensive problem-solving ability, and summary and application ability, respectively. The P-values for all dimensions were less than 0.05, indicating significant differences.

Table 5. Pre-test cognitive ability of experimental and control group.

	Group	Number	Mean	SD	T	P
Audio-visual response ability	Experimental	20	10.52	3.56	0.374	0.356
	Control	20	10.45	3.29		
Comprehension analysis ability	Experimental	20	11.58	3.68	-0.862	0.571
	Control	20	11.84	2.89		
Integrated ability	Experimental	20	10.66	2.94	0.578	0.823
	Control	20	10.48	3.06		
Summary application ability	Experimental	20	10.98	2.69	-0.468	0.469
	Control	20	11.07	2.57		

Table 6. Post-test cognitive ability of experimental and control group.

	Group	Number	Mean	SD	T	P
Audio-visual response ability	Experimental	20	18.74	6.05	4.638	0.000
	Control	20	12.06	3.48		
Comprehension analysis ability	Experimental	20	20.54	5.96	5.181	0.000
	Control	20	12.96	3.42		
Integrated ability	Experimental	20	22.84	5.65	7.856	0.000
	Control	20	13.08	3.25		
Summary application ability	Experimental	20	20.96	4.84	7.068	0.000
	Control	20	11.76	2.06		

Further intra-group cognitive ability tests were conducted on the experimental group and the control group. The results of the intra-group comparison for the experimental group are shown in Table 7, and those for the control group are shown in Table 8. As shown in Tables 7 and 8, the experimental group's cognitive abilities improved by 8.22, 8.96, 12.18, and 9.98 points across the four measurement dimensions, respectively. The control group's auditory-visual reaction ability, understanding and analysis ability, comprehensive problem-solving ability, and summary and application ability improved by 1.61, 1.12, 2.60, and 0.69 points, respectively. The intra-group comparisons for all dimensions in the experimental group showed significant results with a p-value of 0.000, while the control group did not exhibit significant results.

In summary, this study demonstrates that computer-assisted volleyball tactical training methods have a significant positive effect on improving athletes' basic techniques, tactical combinations, and cognitive abilities.

Table 7. Pre-test and post-test cognitive ability of experimental group.

	Pre/post-test	Number	Mean	SD	T	P
Audio-visual response ability	Pre-test	20	10.52	3.56	-6.487	0.000
	Post-test	20	18.74	6.05		
Comprehension analysis ability	Pre-test	20	11.58	3.68	-7.185	0.000
	Post-test	20	20.54	5.96		
Integrated ability	Pre-test	20	10.66	2.94	-8.065	0.000
	Post-test	20	22.84	5.65		
Summary application ability	Pre-test	20	10.98	2.69	-7.248	0.000
	Post-test	20	20.96	4.84		

Table 8. Pre-test and post-test cognitive ability of control group.

	Pre/post-test	Number	Mean	SD	T	P
Audio-visual response ability	Pre-test	20	10.45	3.29	-0.624	0.526
	Post-test	20	12.06	3.48		
Comprehension analysis ability	Pre-test	20	11.84	2.89	-0.365	0.745
	Post-test	20	12.96	3.42		
Integrated ability	Pre-test	20	10.48	3.06	-0.726	0.693
	Post-test	20	13.08	3.25		

Summary application ability	Pre-test	20	11.07	2.57	-0.212	0.713
	Post-test	20	11.76	2.06		

4. Conclusion

This paper integrates computer simulation-assisted technology into volleyball tactical training, designing a volleyball tactical training system and method based on CAI, with the aim of enhancing the teaching effectiveness of volleyball tactical training and improving athletes' cognitive abilities. The effectiveness of the proposed method is validated through experimental verification.

(1) Before the experiment, there were minimal differences between the experimental group and the control group across the nine sub-dimensions of basic techniques and tactical combinations. An independent samples t-test revealed that the pre-test scores for each dimension were not statistically significant ($P > 0.05$). After the experiment, the differences between the two groups in the nine sub-dimensions of basic techniques and tactical combinations significantly expanded, and the experimental group scored higher than the control group in all dimensions. The post-test results of both groups showed significant differences ($P < 0.05$).

(2) There were no significant differences in cognitive abilities (auditory-visual reaction ability, understanding and analysis ability, comprehensive problem-solving ability, and summary and application ability) between the experimental group and the control group in the pre-test, with both groups at the same level. After the experiment, the experimental group's cognitive abilities in the four dimensions exceeded those of the control group by 6.68, 7.58, 9.76, and 9.20 points, respectively, with $P < 0.05$ significance.

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