Ann. For. Res. 65(1): 6607-6619, 2022
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

TEACHING RESEARCH ON TENNIS SERVICE TECHNOLOGY BASED ON MULTIMEDIA IMAGERY TRAINING METHOD

Wanchun Kang,Jian Wang*,Hongseol Kim,Xinchao Du
Department of Leisure Sports,Paichai University,Daejeon 302735,Republic of Korea
workwang2010@163.com

Abstract: Serving technique is one of the basic technical movements in tennis. The traditional tennis technique teaching only pays attention to the training of service technique, but ignores the students' psychological state, which greatly limits the learning effect. The application of multimedia imagery training teaching method in college tennis service technology teaching not only conforms to the characteristics of modern tennis service technology learning, but also increases the stability and accuracy of students' tennis service technology, helping students quickly establish the power of correct action, so as to quickly and effectively master the action of service technology. It is a teaching method that can effectively promote the teaching effect. This paper first analyzes the theoretical knowledge of tennis service technology and imagery training methods, then analyzes the problems existing in the teaching of tennis service technology in colleges and universities, and finally explores the specific application strategies of multimedia imagery training method in the teaching of tennis service technology in Colleges and universities, In order to provide valuable theoretical reference for the improvement of college tennis service technology teaching.

Key words: multimedia imagery training; Tennis service skills; Tennis teaching;

0 Introduction

Multimedia imagery training is a kind of psychological training method which combines the imagery training method with the visual teaching of electricity. In recent years, in the field of sports in China, the imagery training method has been given more and more attention[1]. More and more PE teachers generally use this psychological training method to carry out physical education. This teaching method can not only effectively stimulate the students' motivation and interest in learning, but also help students to master sports and technical movements more accurately. In the traditional tennis service teaching, we do not pay attention to the influence of students' psychological factors, which are not conducive to the improvement of students' learning effect[2]. The multimedia imagery training method is applied to tennis service technology teaching, which can detect the students' wrong actions in time through video, and correct and guide the students in time, so as to improve the learning effect of students.

1 Tennis service Technique Teaching

1.1 tennis service action feature collection based on multimedia imagery training

In the teaching of tennis service, the body is prone to the following problems: in the process of serving, the serious flexibility limitation of the body joints will automatically cause the lack of leg stability, so that the stability of the core parts will be damaged. The problem of body stability will lead to the change of tennis service action and limit the flexibility, which is the bad action

control[3]. The core strength is also an important problem in tennis service. One of the problems is the unrestricted movement pattern of body harmony and symmetry. The transfer of the body center of gravity in the tennis service movement, the lack of alignment when losing balance, the body produced compensation action, the center of gravity between the two legs to complete the conversion process is lack of stability, transverse abdominal muscle and core stability muscle can not be excited. These problems are the problems that appear one after another after the functional action test of the experimental objects. How to solve these problems is the matter that teachers and coaches are worried about at present[4]. It will be a new teaching and training concept to adopt functional movement training in teaching. We can't use it blindly, we should combine the problems in teaching and find a scientific training scheme that can adapt to it. In the teaching of tennis service, the students in group A are given two months' functional action training. The main contents of the training course are shown in the table 1.

Table 1 Functional movement training course

Course stage	Course content	Objective
After warming up	Stretching of body muscles	Increase joint range of motion
Strength training	Dumbbell Row	Improve upper limb strength
Balance training	Flexibility training	Improve flexibility and sense of movement
Core training	Reflex neuromuscular training	Strengthening the core strength and stabilizing muscles of the body
Organizing activities	18 self drafting methods	Improve body control and muscle strength

In the tennis service action mode, the coordination of each joint of the body follows the action basis of joint by joint, and the joint series of the power chain body changing in turn are shown in the table 2.

Table 2 Performance of human joints in service

Joint name	Movement requirements of joints
Knee joint	Stability
Ankle joint	Flexibility
Lumbar vertebra	Stability
Hip joint	Flexibility
Wrist joints	Flexibility
Elbow joint	Stability

The body is in a completely closed chain of sports to complete tennis service technology. In this closed chain of motion, the body should ensure enough flexibility and stability, including the stability of the spine on the sagittal plane and the stability of the stepping part, the flexibility and stability functions of the double bones, knees and double pedals, coordination and cooperation of the muscles across multiple joints, the flexibility and stability between the upper and lower limbs natural balance and muscles, flexibility and stability used for rotation and lateral[5]. The extension,

internal rotation and internal retraction of one side of both shoulders are combined with flexion, external rotation and extension of the other limb, and the leg splitting ability is achieved when the pelvis and body core are stable. In the case of maintaining the stability of pelvis and extended leg, the active flexibility of the posterior thigh muscle group, fat intestinal muscle and soleus muscle, pelvis[6]. Whether the core part of the body and shoulder belt are stable in many aspects are all the statements of the stability of the body's reflection and the movement of the body's center of gravity. In this way, the energy transfer in the closed chain of tennis service technique will also decrease.

As shown in the figure 1, the pyramid model of functional training is shown. The first level is the training of basic sports abilities. It is necessary to train at the first level, whether it is an athlete or an ordinary person; The second level is the training of general sports function, which is based on the first level, which is the basic sports ability that athletes must possess after having basic stability, flexibility and correct movement mode[7]. The third level of functional training tends to be more specialized, according to the specific needs to determine. For the functional training of competitive sports, the first two are the basic training content level. Only by improving the pyramid tower foundation can athletes develop higher and further on the road of specialization. At present, the functional training mode should adopt four-layer pyramid model. The first layer is to develop the ability of coordination, stability, flexibility and other sports, which is the basis for the establishment of the action mode efficiently; The second layer is to establish a high-quality body function movement model[8]. The third level is to develop the sports ability needed for the development of the target sports special technology.

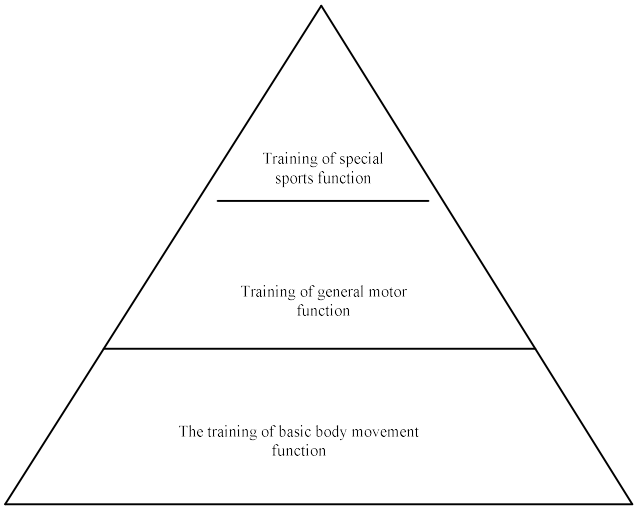

Fig. 1 Pyramid model of functional training

If the body is good at these aspects, the technical action of tennis service will be completed more smoothly, the force will be more harmonious, the body will be naturally coordinated and balanced, and a good service will be achieved. Tennis service is completed by the body in a complete open power chain. In order to ensure enough flexibility and stability of the joints, the stability of the spine and the knee joint in the sagittal plane, the flexibility and stability of the skeletal joint and the double step, the muscle connection of the adjacent joints or joints, the flexibility of the ligaments in the posterior thigh, and the rotational stability of the skeletal joint

should be included[9]. The flexibility and extension range of the shoulder joint, the stability of the elbow joint, the symmetry of both sides of the body, etc. The stability of the above links, or the degree of flexibility training, will affect the final hitting effect and hitting quality. If one or more of the above links are abnormal, the dependent links or joints will appear compensatory action, Not only that, the energy transfer effect in the chain of tennis service technical action will also decline[10]. On the contrary, if the corresponding links are improved and improved, the energy transmission will be more smooth and economical, without a lot of energy leakage, and there will not be too many compensatory actions in each link, so as to ensure the integrity and smoothness of technical actions and the smooth connection of energy transmission. Finally, good service quality and strong terminal output power are achieved[11]. And then effectively prevent the emergence of sports injuries.

1.2 Analysis on the mechanical characteristics of tennis service

In tennis, the player has two chances in every service in his service, and if the player has scored successfully in one set, he does not need two[12]. The difference between the first and second is the order of service. However, whether one or two, the technical action of tennis service can be divided into the following parts as shown in the figure 2:

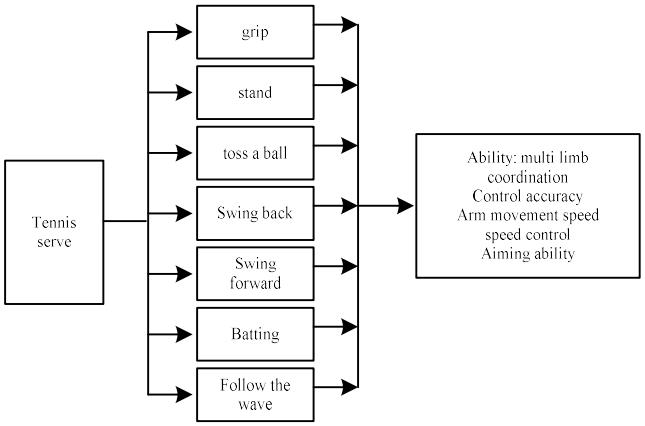

Fig.2 The composition of tennis service technique and the illustration of the perceptual movement ability required by tennis technique

According to the human body model and the standards of vrml97 and h-animals. 1, the human body can be divided into skeleton layers and part layer[13]. The skeleton layer defines the position and degrees of freedom of the main joints of the human body, as well as the hierarchical relationship between joints and parts. It is a tree shaped multi rigid body system composed of finite rigid bodies connected by spherical hinges[14]. On the premise that the influence of muscle deformation on the mass distribution of each limb can be ignored, each limb can be abstracted as a rigid body, which can increase the expressiveness of the external details of human motion by connecting the geometric information of each limb. Suppose the human body structure is t_0, common $q_n^m(t)$ is composed of three rigid bodies, which are defined as follows:

$$\text{Motion}(t)=\left\{\left\langle t_0,\ \text{posture}\ \left(t_0\right)\right\rangle, t_0 \in T\right\}$$
$$=\left\langle p_0^m(t), q_0^m(t), q_1^m(t), \cdots, q_n^m(t)\right\rangle \quad (1)$$

For the tree model of the human body defined above, the system parameters is $\dot{x}_{i-l}$, service strength $\dot{\theta}_i$, the ball speed is $\dot{v}_{i-1}^{+}$, euler recursive equation of motion is used. The specific equation is as follows:

$$v_i^{'}=\dot{x}_{i-l}\dot{v}_{i-1}^{+}\dot{\theta}_i \quad (2)$$

Further combined with the characteristic parameters of human mechanics $\dot{a}_{i-1}$, the results are as follows.

$$\dot{a}_i=\dot{x}_{i-1}^{'}\dot{a}_{i-1}\dot{\theta}_i\dot{\theta}_i^{+}v_i\dot{s}_i\dot{\theta}_i \quad (3)$$

The vector from the initial position q of the joint rigid body to the predetermined space is:

$$L_i=\begin{bmatrix}-q_{i.1} & -q_{i,0} & -q_{i.3} & -q_{i2}\\ -q_{i2} & -q_{i.3} & -q_{i.0} & -q_{i.1}\\ -q_{i,3} & -q_{i2} & -q_{i.1} & -q_{i.0}\end{bmatrix} \quad (4)$$

The acceleration of joint rigid body is as follows:

$$\dot{V}_i=\ \text{Motion}\ (t)\text{-}L_i\dot{a}_i \quad (5)$$

The rotation axis of the joint rigid body is:

$$z^a=X_{-1}^{'}a_{i-1}+\begin{bmatrix}R_0^{'}Ri^{+}\overrightarrow{\omega_i}^{+}+\vec{\omega}_i\\ r_i^{'}\times\omega_i^{'}\end{bmatrix} \quad (6)$$

In the above algorithm, $\overrightarrow{\omega_i}^{+}$ is the force vector of the sphere, $\vec{\omega}_i$ is the resistance vector. Ri^{+} is the degree of exertion, $R_0^{'}$ is the initial load of the sphere, $X_{-1}^{'}$ is the service moment. Furthermore, the quartic equation and Euler angle equation are used to calculate the joint load and moment[15]. The velocity a, acceleration b and air resistance c of the joint are calculated by quartic equation, and the joint load is calculated by the following formula.

$$\overline{z^a z^b}=\begin{bmatrix}z^a\times 1\\ -b^b\times \mathrm{c}^a\times a^c\end{bmatrix} \quad (7)$$

The results are as follows:

$$\begin{bmatrix}a\\ b\\ c\end{bmatrix}\times\begin{bmatrix}-a\\ -b\\ -c\end{bmatrix}=\begin{bmatrix}0 & -c & b\\ c & 0 & -a\\ -b & a & 0\end{bmatrix} \quad (8)$$

If the radius r connecting the moving particle and the center of the circle turns in T in unit time, Rad is the running speed of the tennis ball, S^{-1} is the tennis running distance, the angular velocity after serving can be obtained.

$$\omega = R\overline{z^a} z^b / T\left(R\,a\,d(a,b,c) * S^{-1}\right) \quad (9)$$

When the interaction force between objects is m and the various moving forces are a (n), the torque transfer parameters are as follows:

$$F = M\omega \times A(N) \quad (10)$$

The torque F is the product of force N and arm m, which makes the object rotate

$$T = F \times R(N\text{m}) \quad (11)$$

The above model can be used to analyze and verify the human movement and simulate the real human movements skeleton movement. On the basis of skeleton movement, this paper uses the Vicon motion capture system to collect the human body movement case data, cleans and filters the punctuation data through viconiq software, establishes the three-dimensional skeleton model of human body by using VH motion modeling software developed by the computer of the Chinese Academy of Sciences, and makes use of the above equation to calculate the human body kinematics and dynamics data[16]. After full activity, 6 high-level athletes try to do four actions, namely, one leg splitting, one parallel leg and two legs splitting, two parallel legs, and two parallel legs to the target area of L * l meter[17]. Each player is required to perform three actions respectively, and record the EMG data of each service.

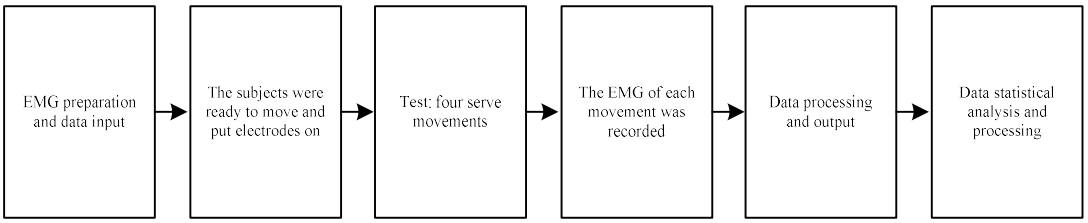

Fig. 3 Tennis service EMG test flow chart

After processing with the data software provided by the computer of Chinese Academy of Sciences, the kinematic and dynamic parameters will be output[18]. The kinematic parameters mainly include the speed of service, various angles of shoulder joint, and the dynamic parameters mainly include shoulder load and torque. With the development of sports, two basic control systems are often mentioned[19]. The two control systems are: open loop control system, which is based on the mechanical control design model. The following is a graphical way to understand these two theories.

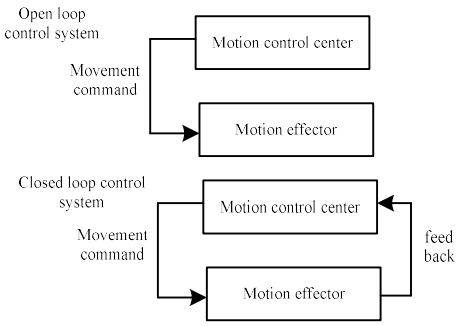

Fig. 4 Diagram of open loop system and closed loop system of motion control

As can be seen from the figure 4, the difference between the two systems is mainly manifested in two aspects. First, there is feedback in the closed-loop system, but there is no feedback in the open-loop system. In human movement, feedback is the information transmitted by various receptors to the control center, which can make the control center correct the action in time. In the complex human movement, feedback mainly comes from visual and auditory receptors[20]. The second important difference is the motion command from the control center. In the open-loop system, the motion is controlled online without feedback. The command contains all the necessary information to make the effector complete the specified motion. Through comparative analysis, the service in tennis belongs to the open-loop control system without feedback, because the tennis player's service technology is the only technology which is not affected or interfered by the opponent and the environment, and is completely controlled by the servicer itself.

1.3 Optimization of tennis service teaching method

According to the relationship between different learning stages and athletic ability, Ekman puts forward a hierarchical model of the relationship between ability types, which shows that the stage of action automation can directly reflect the athletic ability of athletes. At present, the theory of action learning is divided into three stages: generalization, differentiation and automation. In the generalization stage, there are many uncoordinated actions and mistakes; in the differentiation stage, there are fewer mistakes; in the automation stage, there are stable and highly consistent actions, basically forming habitual actions. This paper focuses on the analysis and research of tennis service action based on action learning theory. First of all, the research objects of this paper are professional tennis players and non professional tennis players. They belong to the action automation stage in the action learning stage, so they have a high degree of consistency in the service action. Therefore, in this case, to explore the difference between the success and failure of tennis service, or whether the main factors leading to the success and failure of service are caused by the difference in action.

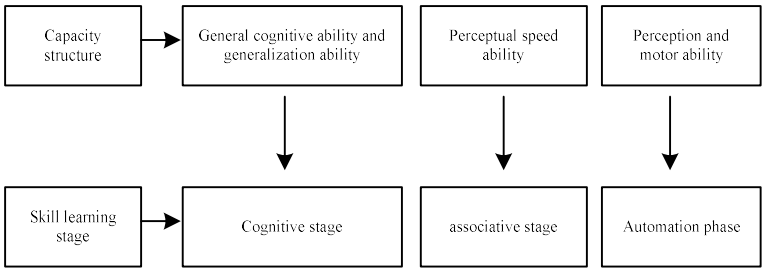

Fig. 5 Capability type relationship hierarchy model

In order to detect an effective moving target, the two frame difference method needs to meet the following conditions: the target must have a moving speed, the background scene is still and its gray value changes little, other interference noise is small and the gray value changes relatively large. Due to the influence of noise and background brightness, these factors will affect the effect of two frame difference image in different degrees. The operation process of this algorithm is as follows:

Set D_K (x,y) as the difference result image, and the gray values at the midpoint (x, y) of frame k-1 image and frame K image are f_k(x,y) and f (x, y). Use the following formula to process the difference between frame K-1 and frame K, where D_k(x,y) is the result image after difference calculation

$$D_k(x,y) = T\left|f_k(x,y) - f_{k-1}(x,y)\right| \quad (12)$$

Then, the following formula is used to threshold D_k(X, Y) to detect the background T and moving target.

$$T_k(x,y) = \begin{cases} 1 & D_k(x,y) \geq T \\ 0 & D_k(x,y) < T \end{cases} \quad (13)$$

Where t is the threshold, which represents the target moving area in the image. The accuracy of the detection formula reflecting the changing position of the target depends on the selection of the threshold in the thresholding calculation process. In the Gaussian mixture background model, the color information between pixels is defined as uncorrelated with each other, and the processing of each pixel is also independent of each other X_i. In a video image, the change of the value of each pixel in the image sequence can be regarded as a random process of generating. That is to say, Gaussian distribution can be used $\sum i,t$ represent the law of the color of each pixel. For the multimodal Gaussian distribution model, each pixel in the image is given a different weight e, and then multiple Gaussian distributions are superimposed according to different weights to establish the model. Each Gaussian distribution corresponds to the color state of a possible pixel. As time goes on, the weight and distribution parameters of each Gaussian distribution will be constantly updated. When processing the color image, it is assumed that the three RGB color channels of the pixel are independent of each other and the variance is the same. Gaussian mixture background modeling in order to describe the state of a pixel at a certain time, K Gaussian models are established for the pixel. The probability function of Gaussian mixture distribution is as follows:

$$P\left(X_i\right) = \sum_{i=1}^{K} \omega_{i,t} \times \eta\left(X_i, \mu_{i,t}, \sum i,t\right) \quad (14)$$

$$\eta\left(X_t, \mu_{i1}, \sum i,t\right) = (2\pi)^{\frac{n}{2}} \sum i,t \frac{1}{2} e^{-\frac{1}{2}\left(x_i - \mu_{i,x}\right)^T \Sigma_i^{-1}\left(x_t - \mu_i\right)} \quad (15)$$

Based on the above algorithms to achieve the optimization of tennis teaching methods, colleges and universities want to better carry out after-school sports competition activities, so that

students get all aspects of exercise from the activities. First of all, we must change our ideas, strengthen the attention to after-school sports competition activities ideologically. In the process of teaching tennis service technology, we should carry out targeted teaching according to the individual differences of students. For students with small degrees, weak acceptance ability and poor tennis foundation, we can first cultivate their interest in tennis, make them fully feel the value and charm of tennis, and then appropriately slow down the speed of explanation, and organize them to watch training videos repeatedly, correct each non-standard and incorrect service action one by one until it can complete the tennis service action independently, skillfully and accurately, and then teach the corresponding technical skills to achieve the gradual improvement of its service skills. In tennis competition, due to the strong competition, the action range is also relatively large, especially in the service technique, so it is easy to have some sports injuries, such as wrist injury, elbow injury and so on. Therefore, PE teachers should also use the multimedia imagery training method to play relevant video cases to students to explain the possible sports injury knowledge and preventive measures in tennis, and introduce the corresponding action skills, taboo knowledge and precautions, so as to enhance students' self-protection awareness, to minimize the incidence of sports injury in tennis.

2 Analysis of experimental results

The subjects of this study were 25 male undergraduates with an average age of 20.25; There are 5 girls, aged 20.46). The research object is to strengthen the application of leading racket, throwing ball, hitting action and following swing in tennis service teaching. In order to ensure the reliability and validity of the technical evaluation standard, five experts were interviewed. From March 2020 to June 2020, the teaching experiment was carried out. The total teaching hours were 40 class hours, and each class hour was 45 minutes. The samples of online course selection were randomly divided into the experimental group and the control group. Each class selected 30 boys with similar basic quality. Before the experiment, the basic quality of the experimental group and the control group were compared.

Table 3 Comparison of basic quality between experimental group and control group

Test content	Experience group	Control group	P
	average±standard deviation	average±standard deviation	>0.05
Height/cm	174.8±0.51	175.2±0.48	>0.05
Weight/kg	68.4±0.59	67.8±0.63	>0.05
Badminton throw/m	7.99±0.74	8.21±0.58	>0.05
Standing long jump/m	2.49±0.32	2.58±0.29	>0.05
Turn back on tennis court	28.32±0.75	30.19±0.24	>0.05

After the experiment, through a random order, three experts at the same time on the same court students tennis service technical evaluation and effectiveness assessment. The table showed that before the experiment, there was no significant difference in the physical indicators between the control group and the experimental group ($P > 0.05$), and the basic level of the body was similar.

At the end of the experiment, the two groups of students' basic skills were assessed, such as students respectively in the inner corner and the outer corner of the five ball, in the diagonal field can score, otherwise will not score. After the experiment, the rationality and effectiveness of the two groups of students' tennis service skills were evaluated and analyzed. The results are as shown in Table 4.

Table 4 Comparison of rationality and effectiveness of service skills between experimental group and control group(N=30)

Evaluating indicators	Experience group	Control group
Number of people	30	30
service up to standard	27	19
Launch compliance rate	65.8	56.3
Skill attainment (person)	26	18
Skill attainment rate (%)	86.7	60

The above table shows that the students in the experimental group mastered the basic technical movements to service better than those in the control group. It shows that the teaching method of tennis service based on the control theory of movement skills is better than the traditional teaching method, and it also helps to improve the effectiveness and stability of service. Through the action control theory, this paper analyzes the new teaching method and four important links in the process of serving, such as throwing the ball and leading the racket, so as to provide theoretical support for the advantages of the new teaching method. In teaching, in order to master the skills of tennis service, we should consider the reasonable effectiveness of the action, and make the muscles participating in the activity coordinate. The theory of action control information first studies the coordinated movement of human body to the control of nervous system, through which people can effectively complete all kinds of action skills in various complex and changeable environments.

Table 5 Control characteristics of action information

Function of feature stage	Finding and confirming signals in stimulus phase	Reaction selection stage selection stage	Organize and start action in the reaction process stage
Types of information processing	Parallel	Parallel and sequential	Sequence
Stimulus reflects the role of the number of choices	Small	Large	Nothing
Need attention	Nothing	Sometimes	Yes

Two control systems are put forward in the development of movement department, namely "closed loop control system" and "open loop control system""Open loop control system" is a kind of fast action under the control of the central nervous system, which needs little attention to correct the action and needs to select the "action program" in advance. Tennis service action is a short-

time and fast action, which belongs to the discrete action of open-loop control mode. Therefore, in the teaching process of tennis service, the whole action should be organized in advance. The action procedure mainly includes the specific muscle group that produces the action, the working sequence of participating muscle group, the time and sequence of muscle strength and contraction, etc. This paper analyzes the four important links of throwing, leading, hitting and following in the complete tennis technical action, and obtains the "two-dimensional classification system of tennis service technical action process" through the first decomposition and then integrity, from unarmed to holding, action time, range, body and muscle and environment changes.

Table 6 Two dimensional classification of Tennis Service Technique

Environment	Limb and muscle changes		
	Unarmed	Holding	
		Beat	The Ball
Movement change	Free hand penalty	Practice falling ball	Toss - Lead - hit - follow the swing
Fixed change	Free hand practice throwing	Practice hitting the ball at a fixed point	Throwing - lead action

From the analysis of the action control theory, the tennis service technique exercises closely among the various links, in which the batting and the following wave belong to the high organization (Association) skill, so in different links, according to the characteristics of the action, the decomposition method or the complete method is reasonably used to practice. The new teaching method designed by action control theory improves the novelty of teaching design of teachers and the comprehensiveness of students' mastering technical actions. The perfect training method is arranged reasonably in tennis teaching, so as to improve the rationality and effectiveness of tennis serving technical action. The tennis service action is divided into four important links. According to the characteristics of tennis service technique, the changes of movement time, range, limbs and muscles are adjusted, and the key and difficult points of different links are reasonably arranged to design the training contents. For example, throwing, shooting, hitting, and practicing step by step with each step of the wave can help to master the complete technical movements.

3 Conclusions

Appropriate teaching methods can improve the novelty of teachers' teaching design and the comprehensiveness of students' mastery of technical movements. According to the characteristics of the action, using reasonable and effective practice method is the key to mastering the technical action. Through the preliminary attempt of tennis service, it aims to provide reference for physical education teaching. Strengthen the new teaching methods, mainly to guide learners to actively participate in the complete and correct action, according to the set action procedure, step by step to master the tennis service action.

Reference

[1] Chandrakala S , Jayalakshmi S L . 2019,Generative Model-Driven Representation Learning in a Hybrid Framework for Environmental Audio Scene and Sound Event Recognition. IEEE Transactions on Multimedia, PP(99):1-1.
[2] Robinson G , Robinson I . 2020, Model trajectories for a spinning tennis ball: III. The effect of a light wind on ground strokes. Physica Scripta, 95(9):095215 (17pp).
[3] Tabrizi S S , Pashazadeh S , Javani V . 2020, Comparative Study of Table Tennis Forehand Strokes Classification Using Deep Learning and SVM. IEEE Sensors Journal, PP(99):1-1.
[4] Kacprzak E , Koesten L , Ibanez L D . 2019, Characterising dataset search-An analysis of search logs and data requests. Journal of web semantics:, 55(MAR.):37-55.
[5] Tang K , Huo L J . 2021, Optimizing Synchronization of Tennis Professional League Live Broadcast Based on Wireless Network Planning. Mobile Information Systems, 2021(7):1-9.
[6] Wang Q . 2021, Tennis Online Teaching Information Platform Based on Android Mobile Intelligent Terminal. Mobile Information Systems, 2021(12):1-11.
[7] Skublewska-Paszkowska M , Powroznik P , Lukasik E . 2020, Learning Three Dimensional Tennis Shots Using Graph Convolutional Networks. Sensors, 20(21):6094.
[8] Roaneslozano E , Casella E A , Hernando A . 2020, Diagnosis in Tennis Serving Technique. Algorithms, 13(5):106.
[9] Drees C , Knieb M , Fechner A . 2021, Detection of illegal treatment of table tennis rackets using gas chromatography coupled to ion mobility spectrometry – A feasibility study. Analytica Chimica Acta, 34(2):338227.
[10] Oshita M , Inao T , Ineno S . 2019, Development and evaluation of a self-training system for tennis shots with motion feature assessment and visualization. The Visual Computer, 35(3):1-13.
[11] Umek A , Tomai S , Kos A . 2019, Application for Impact Position Evaluation in Tennis Using UWB Localization. Procedia Computer Science, 147(4):307-313.
[12] Robinson G , Robinson I . 2019, Erratum: Model trajectories for a spinning tennis ball: I. The service stroke (2018 Phys. Scr. 12 123002). Physica Scripta, 94(12):129601.
[13] Li Y , Kim K , Ding Y . 2021, Early Warning System of Tennis Sports Injury Risk Based on Mobile Computing. Mobile Information Systems, 12(3):1-10.
[14] Zhao D , Kang H L . 2020, Practice Exploration of Flipping Classroom in Table Tennis Club in the Informatization Age. Procedia Computer Science, 166(4):175-179.
[15] Wu W L , Liang J M , Chen C F . 2021, Creating a Scoring System with an Armband Wearable Device for Table Tennis Forehand Loop Training: Combined Use of the Principal Component Analysis and Artificial Neural Network. Sensors, 21(11):3870.
[16] Hegazy H , Abdelsalam M , Hussien M . 2020, Online detection and classification of in-corrected played strokes in table tennis using IR depth camera. Procedia Computer Science, 170(11):555-562.
[17] Gourari A E , Raoufi M , Skouri M . 2021, The Implementation of Deep Reinforcement Learning in E-Learning and Distance Learning: Remote Practical Work. Mobile Information Systems, 9(11):1-11.

[18] Wang B , Zhang R , Xi C . 2020, Virtual and Real-Time Synchronous Interaction for Playing Table Tennis with Holograms in Mixed Reality. Sensors, 20(17):4857.
[19] A Bravo-Sánchez, P Abián, Jimenez F . 2021, Structural and mechanical properties of the Achilles tendon in senior badminton players: Operated vs. non-injured tendons. Clinical Biomechanics, 85(2):105366.
[20] Steels T , Herbruggen B , Fontaine J . 2020, Badminton Activity Recognition Using Accelerometer Data. Sensors, 20(17):4685.