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Effects of Applying Multimedia into Learning Plan to Improve Table Tennis Serving and Receiving Skills of University Students

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Abstract

Background and Aim: As is known, table tennis is a popular sport that not only enhances physical fitness but also exercises one's cognitive reaction and other aspects. Moreover, table tennis has been a fundamental course in many universities nowadays in China and other countries. However, there is still a lack of systematic and comprehensive learning plans or teaching plans, especially for university students in the Chinese context. That will lead to a negative effect on students' performance in table tennis skills. This study attained the objective of analyzing the magnitude of multimedia's influence on the learning effect of receiving and serving skills in table tennis among college students by establishing the hypothesis of profitability, which was analyzed and achieved by comparing the performance of 60 university students in the experimental group and the control group in an 8-week pre-test and post-test.

Materials and Methods: Before the experiment, the researcher interviewed several experts to obtain the current status of table tennis teaching and learning, and refined the new learning program incorporating multimedia instruction based on the experts' recommendations. This study was Quasi-experimental research. The population was 240 students who had no training in base table tennis from the sports student club of Shenzhen University of Technology in the academic year 2023. Then, 60 college students were selected accidentally and divided into two groups by the matching method: control and experimental groups. Then, an 8-week experiment was conducted to compare the differences and effects of multimedia teaching with traditional teaching methods. The results were analyzed by an independent sample t-test and one-way ANOVA to figure out the effect of the application of multimedia in learning, serving, and receiving capabilities of table tennis via the values of t-test statistics.

Results: There is a significant difference in the outcomes between the pre-test and post-test (t=0.159and-10.740, p<.001*) concerning the serving and receiving abilities of table tennis, which demonstrated that the multimedia learning plan has a great effect on students' performance in serving and receiving skills.

Conclusion: The result of the experiment is that the hypothesis is valid, and the learning program using multimedia (post-test) has a greater positive impact on students' learning outcomes than the traditional learning program. Research outcomes will be capable to applied in other contexts with multimedia learning plans and promote the development of the physical education field.

Keywords: Multimedia; Learning Plan; Table Tennis Serving and Receiving Skills

Introduction

All countries are very supportive of the development of physical education and sports, and there are many sporting events and activities worldwide. One of the reasons for this phenomenon is that physical exercise has a multifaceted positive impact on human development, which covers many aspects, including physical, psychological, and social. Physical activity helps to improve the physical fitness and health of students. It enhances cardiorespiratory fitness, improves the body's immunity, promotes healthy bone and muscle development, regulates body weight, and prevents obesity. Physical activity is also important for students' mental health.

It reduces stress and anxiety, improves students' self-esteem and self-confidence, as well as promotes better emotional management and mental toughness. Zhou and Jin (2021) in their research paper, "The Theory and Practice of Physical Education and Sports to Enhance Learning Effectiveness from Brain Science", stated that physical exercise has a positive effect on adolescents' mental health, which is reflected in the fact that increasing physical activity time can improve mental health and psychological adjustment ability. This conclusion remains robust after dealing with endogeneity issues and sample selection bias. The mechanism of influence, adolescents' physical activity can strengthen parent-child relationships and enhance psychological well-being. The effects of physical activity on adolescents' mental health are class-

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differentiated, with higher-class adolescents experiencing greater mental health benefits from physical activity.

Research has shown that regular physical activity improves students' cognitive functioning, including attention, memory, speed of thought, and creative thinking skills. This is because physical activity promotes the development of structures and functions in the brain associated with learning and memory. Physical activity often requires teamwork, which helps students develop social skills such as communication, cooperation, and leadership. Through physical activity, students learn how to function in a team, how to deal with victory and defeat, and how to respect others.

Building on this foundation, many countries incorporate physical education and sport into their schooling. In Chinese physical education classrooms, teachers guide students to learn many sports, and table tennis is one of them. Table tennis, as a world sport, is more popular among the college student population, and this sport is beneficial to physical coordination, reaction speed, and strategic thinking.

Based on the impact of physical education on students' physiological and psychological development, and the problems that exist in physical education in China, the Chinese Government has issued documents in support of physical education in schools. The document points out that physical education has a unique function in cultivating students, including their spirit of patriotism, collectivism, and socialism their willingness to strive for excellence and tenacity, and realizing physical education's contribution to students' intellectual development and mental health education (Government Portal of the Ministry of Education of the People's Republic of China, 2020).

Yang (2021) believed that in college sports, for the teaching of table tennis, teachers not only have to teach students some basic movements; but also the limited classroom time, so that students can simply understand the various technical movements of table tennis, based on the level of the teacher, the effect of the picture, the classroom time and other reasons, teachers and students in the process of table tennis technology teaching will be very limited, the teaching and learning activities will be affected. To solve this problem, many sports teachers tend to break down a certain action and demonstrate it repeatedly, which is time-consuming and ineffective. Multimedia technology, on the other hand, combines video animation, text, graphics, sound, images, and other media in one. Using multimedia equipment can transform complex text into an easy-to-understand form to present to students, so that students can get a better feeling from multiple senses. This is easy for students to accept and remember. Multimedia technology is an important auxiliary tool for teaching table tennis in colleges and universities.

Liu (2022) believes that the following problems exist in the teaching of table tennis in Chinese universities today: First, students' lack of interest in learning table tennis; second inadequate teaching evaluation system; third, low professionalism of teachers; the last, limited facilities for table tennis venues. Table tennis receiving and serving techniques are also an important part of table tennis teaching and learning. Previously, the traditional table tennis receiving and serving techniques, as the introductory technical requirements, could be easily passed over by the teacher in a single sentence, and students wanted to learn more quickly and master more complicated techniques as soon as possible, while ignoring this requirement. Therefore, the use of multimedia learning plans to assist teaching is an approach that is easily accepted by both teachers and students to better learn table tennis catch and serve techniques.

Studying the effects of multimedia teaching methods on university students' table tennis serve and catch skills can help improve and optimize the teaching of university physical education, especially table tennis, so that students will better understand how to master table tennis skills.

Contributing to the enhancement of students' learning experience, the research process can increase students' motivation and participation in learning, especially with the adoption of more innovative and attractive teaching methods. Highlight the potential impact of different teaching methods in meeting students' individual learning needs and improving their overall competence.

Contribute to the development of physical education theories: provide empirical support for physical education theories, particularly in the specific sport of table tennis, enabling a deeper understanding of how teaching methods affect skill acquisition and motor performance.

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Contribute to the development of future research: the results of the study may provide direction and rationale for future research in the field of physical education teaching methods, emphasizing the long-term effects of different teaching methods.

This study was conducted based on the above problems, based on which the impact of multimedia teaching methods on college students' table tennis skills, including serving and receiving skills, can be investigated to solve a series of problems that may involve teaching effectiveness, students' participation, skill development and the optimization of educational resources. Effectiveness is an example that includes teaching methods, student engagement and motivation, individualized instruction for different students, overall student skill development, and optimization of educational resources. This study can provide a deeper understanding and practical guidance for teaching table tennis at university, thus improving the quality of teaching, students' learning experience, and overall development of table tennis skills.

The researcher enquired about domestic and international dissertation websites, including CNKI, Wipro, Google Scholar, etc., and there is research in the academic world on physical education, table tennis education, training of table tennis techniques, multimedia teaching, and learning. However, no research has been carried out on multimedia teaching methods and table tennis receiving and serving techniques. For the above reasons, the researcher decided to carry out this study.

Objectives

To study the effect of applying multimedia to learning plans to improve the table tennis serving and receiving skills of university students

Literature review

The table tennis serve and catch are crucial aspects of the game, they determine the start and pace of the game. There are some techniques, including the serving technique and the receiving technique. This part of the literature will sort out the skills and points of receiving and serving in table tennis to lay the foundation for subsequent research.

1. Table tennis serving and receiving techniques

A study on table tennis serving strategies and the importance of serve technique in table tennis matches, reveals the strategic role of the serve in table tennis matches through a literature review and technical and tactical analyses, which pointed out that a precise serving strategy not only establishes an advantage for the player in the match but also effectively confuses the opponent to control the rhythm of the match. Pradas et al (2023) have proposed that the spatial distribution of serve and receive, and gender differences were analyzed for elite-level table tennis players. The results showed significant differences in the spatial choices of serve and receive between male and female athletes, with male athletes tending to utilize specific areas of the tabletop more for serving and female athletes choosing other areas more often. Moreover, Ming (2011) has studied the characteristics of combination techniques in table tennis by observing and analyzing the world's top table tennis players, which presented that the combination techniques commonly used by the top players include pulling and picking and that the effective combination of these techniques is crucial for controlling the game and disrupting the opponent's rhythm. Ping (2022) strove his study into the teaching methods of the downward spin serving technique in college physical education. Through practical exploration, the authors found that integrating interest and practicality into the teaching process can significantly improve students' efficiency in mastering the downward spin serve technique. Yu et al. (2018) examined the differences in lower limb activity between squat serves and standing serves when executing short serves in female table tennis players. It was found that squat serves exhibited a greater range of motion in terms of flexion and extension, internal retraction, and external rotation of the lower limb joints, which may be beneficial in optimizing serve performance in competition and training. When it comes to the receiving capacity of table tennis, Pradas et al. (2023) wrote a research paper, the purpose of which was to analyze gender differences in the spatial distribution of serve and receive in elite table tennis players. The study recorded and analyzed 24 matches of 24 top athletes of both genders,

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consisting of 1177 serves and 5319 strokes (men's matches) and 950 matches and 5097 strokes (women's matches). The results showed significant differences between men and women in their choice of serving and receiving techniques.

2. Multimedia teaching method

The multimedia learning plan is a combination of sound, text, images, animation, video, and other forms of media teaching. This teaching method uses computers and modern communication technology to enhance students' interest in learning through rich audio-visual materials and improve the teaching effect. The main features of a multimedia learning plan include interactivity, intuitiveness, flexibility, diversity, efficiency, and other characteristics. Students can interact with the teaching content through clicking, dragging, and other operations, which helps to increase enthusiasm and participation in learning. Tian (2022) argued that multimedia is a new type of teaching tool that uses text, sound, image, video, and other forms of media comprehensively. Multimedia teaching has the advantages of intuitiveness and flexibility. Applying multimedia teaching to junior high school physical education programs can meet the cognitive characteristics of students at this stage of their development, and is also in line with the educational objectives of this stage. Therefore, it is an inevitable trend to apply multimedia teaching to junior high school physical education teaching. Zhang (2022) has shared the same point that the application of multimedia teaching is conducive to stimulating students' enthusiasm for physical education.

3. Related research

The multimedia teaching methods stimulate students' interest and improve teaching efficiency through interactive and lively presentation, playing a role that traditional teaching methods cannot match. She pointed out that multimedia teaching methods are used in today's teaching, interactive and lively, stimulate students' conception, improve efficiency, play a role incomparable to other carriers, and ultimately form a new learning motivation. It not only enriches the teaching methods and effects but also improves students' participation, cultivates their creative thinking, and improves teachers' teaching quality. It also plays a new role in the information teaching mode. In the teaching practice of vocational schools, multimedia technology has changed traditional teaching methods and enhanced the effectiveness of teaching applications through graphic and textual presentations. However, the application is sometimes imperfect for a few reasons. This thesis focuses on the use of multimedia technology in vocational education. Barrulet (2023) has proposed that the use of multimedia tools in language teaching contributes to the improvement of teaching quality. The multimedia method of teaching can be more effective in teaching a foreign language than the traditional methods of chalk and blackboard. According to the authors, the most common method of teaching a foreign language is the use of textbooks. However, the 21st century offers other possibilities to be used in the learning process, such as multimedia tools. The use of the Internet, newspapers, radio, or television may be an alternative to typical language teaching methods. Multimedia can be defined as an exciting combination of computer hardware and software that allows you to integrate video, animation, audio, graphics, and testing resources to develop effective presentations on an affordable desktop computer. Methods of teaching foreign languages through multimedia are becoming more and more widespread, contributing significantly to improving the quality of teaching and learning.

In conclusion, the multimedia learning plan has important application value in the teaching of table tennis technique, which can improve the learning effect, enhance the learning interest, and promote the mastery and enhancement of technique. However, to give better play to the advantages of the multimedia teaching method, teachers need to improve their teaching skills and multimedia application ability, strengthen the guidance and counseling to students, to better promote students' learning of table tennis techniques.

Conceptual Framework

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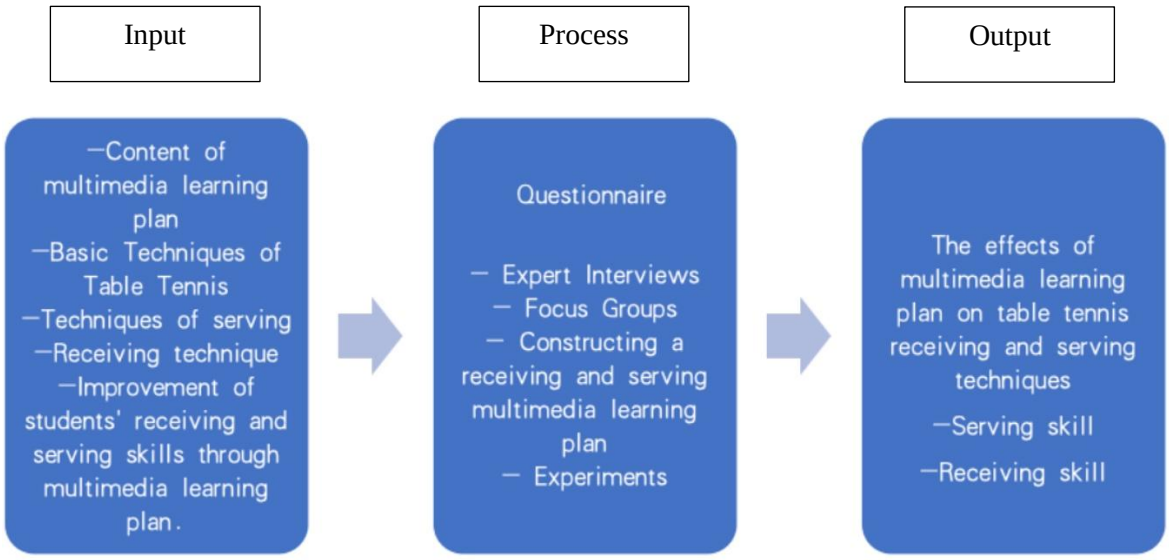

Methodology

Research Design

This research was a Quasi-experimental research design. The research was a group's pre-test and post-test design.

Table 1. Experimental group and control group

Group	Pre-test	Training 1	Mid-test (After 4 weeks)	Training 2	Post-test (After 8 weeks)
Experimental group	O_1	T_1	O_1	T_1	O_1
Control group	O_2	T_2	O_2	T_2	O_2

As Table 1, O_1 =Experimental group; O_2=Control group; T_1=Experimental group Training program stage; T_2=Control group Training program stages.

This study compares and analyzes the data results of serve accuracy, speed of serving, rotation type, success rate of service receiving, response time, and batting quality of the experimental group and the control group before and after 8 weeks of training.

Population and sample

1. Population specification and size

In this study, the population was 240 students who had no training in base table tennis before from the sports student club of Shenzhen University of Technology in the academic year 2023.

2. Sampling techniques

240 students will participate in the 100-meter sprint test, and according to the ranking of the test scores, the researcher chose the students' scores in the ranking 31st- 90th; a total of 60 students were selected to participate in the experiment.

3. Explanation of the matching sample

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The sample of this study is the freshman students of Shenzhen University of Technology, through the serpentine ranked sampling, 60 students from the total number of students as a sample for the 100-meter running ability test, speaking of the students according to the test scores from the lowest to the highest by the order of 1-60, and then through the way of matching (matching) the sample is divided into 2 groups of 30 people in each group, this method ensures that the samples of the two groups before the test have the average ability and the number of gender does not differ or maximally similar. This method ensures that both groups have average ability before the test and there is no difference or maximum similarity in the number of people by gender, then the independent t-test is used to test the difference between the control group and the experimental group and to assess the ability of the two groups.

1------2 12-----11 21-----22 32-----31 41-----42 52-----51
4------3 13-----14 24-----23 33-----34 44-----43 53-----54
5------6 16------15 25------26 36-----35 45-----46 56-----55
8------7 17------18 28------27 37------38 48-----47 57-----58
9------10 20-----19 29-----30 40-----39 49-----50 60-----59

Table 2. The list of the control team and the experimental team

Control team	Experimental team
C1	E1
C2	E2
C3	E3
C4	E4
C5	E5
C6	E6
C7	E7
C8	E8
C9	E9
C10	E10
C11	E11
C12	E12
C13	E13
C14	E14
C15	E15
C16	E16
C17	E17
C18	E18
C19	E19
C20	E20
C21	E21
C22	E22
C23	E23
C24	E24
C25	E25
C26	E26
C27	E27
C28	E28
C29	E29
C30	E30

As shown in Tables 1 and 2, the samples of this study are first-year students at Shenzhen University of Science and Technology. Through simple random sampling, 60 students from the total number of 240 are selected to conduct the 100-meter test. Rank the students in order of their scores on the test from lowest to highest, and choose 31-90th as the sample. The samples were divided into 2 groups of 30 people each by random drawing. This method ensures that both groups of samples have average ability before the test, and the number of people is not different or similar to the gender. Independent tests were then used to test the differences between the control group and the experimental group and to assess the ability of both groups.

3. Participants

The participants were 60 students who studied in the second year at Shenzhen University of Technology, academic year 2023, who had no training in table tennis before.

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IOC Experts: 3 experts (all professional table tennis coaches with more than 5 years of work experience and a master's or doctoral degree) were selected using purposive sampling to assess the questions in the student questionnaire and the expert interview using the Index of Item-Objective Congruence (IOC).

Five experts for interviews, including table tennis coaches, physical education teachers, and table tennis academic experts, were selected through purposive sampling. The experts interviewed all have more than 5 years of work experience as coaches and have master's or doctoral degrees. The expert interviews focused on the keys to developing a learning plan.

Research Instruments

Questionnaire: The researchers used a student questionnaire to understand the participants' cognition of table tennis catching and serving skills.

Interview form: The researchers used interview forms to understand the participants' mastery of skills during their participation in the experiment.

Multimedia teaching program: the multimedia learning plan adopted in this study is mainly video, and the teaching form is that teachers use video to play the video of table tennis catching and serving techniques, and students watch the teaching content in a loop between and after class. The duration of teaching is 4 weeks, 2 lessons per week of 1 hour each. Through many intuitive multimedia video courses, it is easier for students to understand and remember, which is conducive to breaking through the limitations of time and space, learning at any time, and improving the flexibility and convenience of learning.

Data collection

1. A questionnaire survey was conducted on all 60 students using on-site distribution of questionnaires to find out the knowledge of table tennis techniques among non-sports students.
2. Interview form for experts to assess the consistency of the questions in the expert interview form with the objectives through Item-Objective Consistency (IOC), as well as for 5 experts, including table tennis coaches, physical education teachers, and table tennis academic experts were invited to conduct face-to-face interviews to develop the learning plan.
3. Trial the specific learning plan with 5 students to see if it is suitable for student use.
4. Implement the learning plan for 8 weeks, training 2 days a week, 2 hours a day.
5. Tests of table tennis receive and serve were carried out before the start of the training, after 2 weeks of training, and after the completion of the training.

Data Analysis

1. Statistical methods: Descriptive statistics will be used to summarize the data, and a t-test via a software package and ANOVA will be used to test student learning outcomes, including both pre- and post-tests.

2. Content analysis will be used to analyze the information from questionnaires and interview forms of experts for developing a learning plan with multimedia.

Research Process

This research was divided into 7 Steps as follows:

Step 1: Review of Literature and Research

1.1 Review of Physical Education for College Students: A Systematic Review of the Literature Related to Physical Education for College Students, including research on physical education teaching methods and evaluation of teaching effects.

1.2 Review of Table Tennis Serve and Receive Techniques: A comprehensive study of existing literature on table tennis serve and receive techniques, including information on technical essentials, training methods, development trends, and so on.

1.3 Overview of Multimedia Teaching Method: to sort out the current situation and effect of the application of multimedia learning plan in the field of physical education teaching, including the development of multimedia teaching resources, teaching design principles, and other aspects of the literature.

Step 2: Collecting perspectives and reviewing information to form a conceptual framework

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2.1 Determine the research questions and objectives: clarify the purpose of the research, for example, to investigate the influence of multimedia learning plans on college students' learning of table tennis techniques.

2.2 Establish the theoretical foundation and conceptual framework of the study: Based on the literature review, determine the theoretical foundation and conceptual framework of the study, including the principle of multimedia teaching, the theory of table tennis skill learning, etc.

Step 3: Develop the conceptual framework

3.1 Constructing the research framework: Based on the research questions and objectives, establish the research framework and identify the variables, relationships, and hypotheses of the study.

3.2 Determine the research design: Based on the research framework, determine the design plan of the study, including experimental design, sample selection, data collection methods, etc.

Step 4: Construct the research instrument

4.1 Design research tools: according to the research framework, design the corresponding research tools, such as questionnaires, experimental materials, observation record forms, etc.

4.2 Pretesting and adjusting: Pretest and adjust the designed research tools to ensure their rationality, validity, and reliability.

Step 5: Data Collection

5.1 Data collection methods: Use questionnaires, experimental tests, on-site observation, and other methods to collect data related to the research objectives.

5.2 Data collection process: according to the research design, the researcher carries out the study on the subjects and organizes and implements data collection through pre-test and post-test to ensure the completeness and accuracy of the data.

Step 6: Analyzing and Interpreting the Data

6.1 Data analysis methods: Use appropriate statistical methods and software to analyze the collected data, including descriptive and inferential statistics.

6.2 Interpretation and Discussion of Results: To analyze the data results, interpret the findings of the study, and explore the impact of multimedia teaching methods on university students' learning of table tennis skills, as well as the possible mechanisms and influencing factors.

Step 7: Summarizing and writing the final report

7.1 Summary of the research process: Review the whole process of the study, including the main work in research design, data collection, and data analysis.

7.2 Writing the result report: write the research report, including the introduction, methods, results, discussion, and conclusion sections, presenting the contents and conclusions of the study clearly and accurately, and providing detailed descriptions and explanations of the experimental steps and results.

Through the above-detailed description of the experimental steps, the researcher can conduct more comprehensive research on the multimedia learning plan on table tennis receiving and serving techniques, ensure the scientific reliability of the research, and provide effective guidance and suggestions for teaching practice.

Results

1. Exploring the current situation and problems about the effects of applying multimedia to the learning plan to improve the table serving and receiving skills of university students

1.1 Questionnaire Analysis:

Table 3. Questionnaire for university students

Questionnaire items	Totals		Result
	$\bar{x}$	S.D.	
Are you interested in table tennis?	4.5	0.76	Strongly Agree

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Questionnaire items	Totals		Result
	$\bar{x}$	S.D.	
Do you take part in table tennis training or competitions regularly?	4.5	0.76	Strongly Agree
Have you used any multimedia learning apps related to table tennis?	5	0	Strongly Agree
Do you think watching instructional videos can improve your table tennis service skills effectively?	3.8	0.98	Agree
Do you think real-time feedback helps you learn when using multimedia applications?	5	0	Strongly Agree
Do you do practical practice immediately after using multimedia applications?	5	0	Strongly Agree
Would you recommend the multimedia learning app you use to your friends?	3.73	1.03	Agree
Do you think the existing multimedia applications need to be improved to better assist in the learning of table tennis service-receiving skills?	3.73	1.03	Agree
Do you spend time learning and practicing table tennis every day?	3.63	1.22	Agree
Do you prefer to learn table tennis through multimedia applications rather than the traditional way?	3.33	0.94	Neutral

Table 4. was a questionnaire for university students' examination results of interviews with 5 table tennis coaches and a questionnaire survey of 60 students.

In terms of the content validity of the questionnaire, the researchers sent the questionnaire to three experts for verification. The researchers summarized the variables through a literature review and designed a questionnaire. The project goal Agreement (IOC) was used to score the questionnaire items on a scale ranging from -1 to +1. Revisions were made for items that scored less than 0.5 points. On the other hand, items with scores higher than or equal to 0 up to 0.5 are retained.

The reliability of the questionnaire is a method used to assess the quality of the measurement procedure used to collect the data. A Cronbach alpha coefficient of 0.70 or higher means that there is sufficient reliability to determine the internal consistency of the items in the research tool to be measured or the reliability of the mean correlation questionnaire. As a result, Cronbach's coefficient is greater than 0.900 at 0.919, which means the questionnaire is reliable. Therefore, what it can tell is that the questionnaire is valid for investigating the situation and issues of multimedia applications in learning plans under the research context, so that the innovative learning plan with multimedia would be developed according to the experts who have proven and explained the influence of multimedia as follows:

Expert 1: Firstly, it needs to be clear that the goal of training is to improve the skill of table tennis serving and receiving

Expert 2: Table tennis is a sport that requires explosive power and endurance, so we need to improve the skills of students through high-intensity training. In addition, it is necessary to increase the diversity of training, such as through the change of training methods, venues, equipment, etc., to promote the students' physical performance.

Expert 3: The training program should include both serving training and receiving training.

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Expert 4: Table tennis is a fast-paced competition, and students need to have good quick power and explosive power. Therefore, the training should focus on the training of muscle strength, but also focus on the training of the nervous system, to improve the reaction speed and flexibility of the athletes.

Expert 5: When formulating a training program, it is important not to be too single-minded in skills training and neglect the overall development of athletes' physical qualities.

In terms of the perspectives from experts, the application of multimedia did show a positive effect compared with traditional learning plans.

Table 5. Training programmer

basic training	Grip, stance, footwork, stroke technique
physical exercise	Training for cardiorespiratory fitness, building muscle strength, improving flexibility, and increasing reaction time.
technical training	Pull, scrub, slice
Tactical training	Training of basic tactical ideas and simple tactical combinations
Psychological training	Competition, mental conditioning, stress management, and self-confidence development
on-the-spot training	Simulate the real competition scene for confrontation training and improve the actual combat ability.

Table 6. Content of multimedia learning

Learning plan	Details
Video tutorials	Demonstrating standard serve and receive techniques, and slow-motion analysis techniques in detail
Animation demonstration	3D animation shows the movement track and hitting point of table tennis.
Interactive software	allows students to test themselves and give instant feedback through gamified exercise modules

In terms of the outcome of the multimedia learning plan, there are details of the comparison of serving and receiving test scores within the control and experimental group via one-way ANOVA.

Table 7. Comparison of serving and receiving test scores within control and experimental groups via one-way ANOVA

	Group	Mean	SD	t	p	f
PRE1	Cont.	.93	.740			
	Exp.	.97	.718	-.177	.430	.776
MID1	Cont.	2.50	.777			
	Exp.	5.17	.950	-11.903	<.001*	13.986
POST 1	Cont.	6.20	.761			
	Exp.	8.93	.785	-13.693	<.001*	17.884

*p<0.05

The values of the mean exhibited an upward trend from 0.93 to 8.93, respectively, as Table 4.12 demonstrated. In terms of p-value, there is a transparent difference between the pre-test (p=0.430, f=0.430) and post-test (t=-13.693, p<0.001, f=17.884).

According to the mean results of the variables relating to the receiving skill of table tennis among three times tests, it can be told that the teaching plan with the mixture of traditional and multimedia ways presents a great influence (t=-10.740, p<0.001) on the abilities of students, which detailed in table 8 as follows.

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Table 8. The demonstration of mean values of the ability to receive among the control and experimental groups

Group		Mean	SD	t	p	f
PRE2	Cont.	1.40	.814			
	Exp.	1.37	.809	.159	.437	.995
MID2	Cont.	3.43	.774			
	Exp.	5.67	.758	-11.292	<.001*	
POST2	Cont.	6.60	.855			
	Exp.	8.90	.803	-10.740	<.001*	38.041

*p<0.05

Experimental summary

Overall, the experimental results clearly show the significant advantages of multimedia learning plans in improving college students' serving and receiving skills in table tennis. Multimedia tools help students better understand and master complex table tennis techniques through visual, auditory, and interactive multi-sensory stimulation. Compared to traditional training methods, multimedia learning programs can provide more personalized practice opportunities and instant feedback, enabling students to make significant progress in a short period. By comparing the experimental group with the control group, the experimental group showed significant improvement in serve accuracy, speed, and spin type, while the control group showed relatively little improvement.

This shows that video tutorials and animated presentations in multimedia learning programs have obvious advantages in conveying and understanding technical details. Through slow-motion replay and key point emphasis, students can better grasp the technical essentials of serving and receiving. At the same time, the reaction time of students in the experimental group was significantly reduced, and the quality of shots was significantly improved, which further proved the important role of interactive software in training. Interactive software helps students improve reaction speed and technical stability through rapid response training and instant feedback.

In contrast, the traditional training methods in the control group had limited improvement effects in these aspects. In addition, the improvement of comprehensive skills (such as the overall level of serving and receiving, the ability to respond to changes in competition, etc.) in the experimental group was significantly higher than that in the control group. This shows that the multimedia learning plan not only has advantages in a single technology but also can comprehensively improve students' comprehensive skills in table tennis. The diversified training methods and comprehensive coverage of multimedia tools enable students to be effectively trained in all aspects.

Discussion

This study has literature research as well as interviews with experts who are more adept at relevant table tennis teaching and learning programs before the experiment, and finally concluded that multimedia teaching should be used as a new learning program to improve students' learning efficiency. This is because, when collecting information on the current learning status of table tennis among college students, it was found that students were tired of the traditional learning methods, and the receiving and serving skills of table tennis needed to be practiced, which would lead to the inability of students to improve their skills efficiently. Meanwhile, it has also been shown that multimedia instruction, such as video, can greatly enhance students' performance and output (Han, 2019). In addition, few studies concluded that multimedia cannot improve students' learning interest and effectiveness. These provide a substantial basis for this research.

When it comes to comparison between the pre-test and post-test, what it can tell is that the result of the post-test presented a manifest effect of the application of multimedia into the teaching and learning on abilities to serve and receive university students in the research spot. This study shows that the multimedia learning program significantly improves the serving and receiving skills of table tennis students. Compared

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with traditional training methods, multimedia tools can help students master complex technical movements more effectively through multi-sensory stimulation, personalized learning, and instant feedback. In the process of learning and training, the addition of multimedia methods of teaching allows students to generate interest and motivation, such as a video showing a detailed explanation of the movements, to better enable students to understand the essentials and to master the focus of training. After 8 weeks of systematic learning, students developed good learning habits and showed good performance, which also verified the hypothesis of this study and proved that multimedia teaching has a very good effect on improving students' learning. This finding provides a novel and effective method for table tennis skill training, indicating the great potential of multimedia technology in physical education. Compared with the existing traditional training methods, the multimedia learning plan in this study shows obvious advantages. Existing studies mainly focus on the effect of traditional coaching and field practice, but this study provides more dimensions of teaching and training means through the application of multimedia tools. Consistent with the findings of Chinese researcher Yang (2021), multimedia tools can also improve learning efficiency and students' skill mastery. And Zhang (2022) has shared the same point and also pointed out that the application of multimedia teaching to junior high school physical education is an inevitable trend, through a reasonable teaching design to use multimedia teaching flexibly, and in the teaching of multimedia technology through the integration of teaching resources, but also according to the teaching objectives of the series of multimedia courseware. The experimental study of video tools in table tennis teaching: A study of the use of video tools in the teaching of table tennis, such as forehand attack, pivot attack and defiance, and chipping techniques, as well as found that video tools can stimulate students' interest in learning and improve learning efficiency.

Moreover, through this form of teaching, the main content of the teaching to students and the formation of a scientific and reasonable teaching structure are formed, ultimately achieving the optimization of junior high school physical education curriculum teaching purposes. However, there is little research proposing the opposite perspectives of the application of multimedia in the learning process, and the receiving capacities of university students in the Chinese physical education context.

Conclusion

As the objectives of this study are to develop a learning plan with multimedia as well as to investigate the effect of the application of multimedia in the learning process from the students' perspective, there are manifest results following the whole research process of this study which answered the three research questions: 1. What are the problems of learning table tennis serving and receiving skills of university students? 2. What are the key components of multimedia learning plans to improve the table tennis serving and receiving skills of university students? 3. How does the effect of applying multimedia to learning plans improve the table tennis serving and receiving skills of university students? Furthermore, according to the variables concerning serving and receiving competence, there is a significant influence of multimedia instruments on the students' performance on skills via the independent t-test.

Recommendation

1. In table tennis teaching, it is recommended to integrate a wide range of multimedia tools, including video tutorials, animated presentations, and interactive software. The teaching plan should combine the characteristics of these tools to design systematic teaching content and training programs. For example, a video tutorial can be shown before each class to explain the technical points of the day, followed by a detailed demonstration of the technical movements through an animated demonstration, and finally, practice and test using interactive software.

2. To implement a multimedia learning plan effectively, it is suggested to train table tennis coaches and teachers in multimedia teaching skills. The training content should include the use of multimedia tools, the production skills of video tutorials and animation demonstrations, the operation and application of interactive software, etc. Through systematic training, to improve teachers' multimedia teaching ability, so that they can skillfully use multimedia tools to teach.

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3. Establish a multimedia learning resource library for students to learn and practice independently. The resource base should include video tutorials, animation demonstrations, and interactive software for various technical movements, as well as detailed technical analysis and training methods. Students can choose their learning content and exercise items according to their own learning needs, and learn and improve their skills anytime and anywhere.

4. According to the actual demand for table tennis teaching, customized multimedia tools are developed. For example, detailed video tutorials and animated demonstrations for different technical movements can be developed, and interactive training software and gamified exercise modules can be designed. The development of multimedia tools should pay attention to user experience and practicability to ensure that students can obtain good learning results and experience in the process of using them.

5. Establish multimedia teaching demonstration bases in universities or table tennis training institutions to promote and apply multimedia learning programs. The demonstration base can be used as the experiment and promotion platform of multimedia teaching, to carry out the research and practice of multimedia teaching, and accumulate experience and results. Through the construction and operation of demonstration bases, we will promote the application and popularization of multimedia learning programs in a wider range.

Further Research

Since the research aims to figure out the effect of multimedia applications on learning output and performance of two skills concerning table tennis, there is still a lack of further study in the future application of multimedia programs and tools in real life, which will benefit the development of all walks of life.

1. Effects of multimedia learning programs on elderly athletes' serving and receiving skills.
2. Application of multimedia tools to improve the basic skills of children in kindergarten school.

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