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Optimization Design of Physical Education Curriculum Resources for "Sports Physiology" in Universities Based on Digital Perspective

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Abstract: With the rapid development of technology, digital technology has become an important driving force for educational innovation. This study aims to explore how digital technology can be effectively integrated into the course of Sports Physiology in universities, in order to improve the quality of teaching resources and the learning effectiveness of students. To achieve this goal, a mixed method design was adopted in the study. Firstly, a questionnaire survey and interviews were conducted to collect the usage and needs of physical education teachers and students in universities regarding the existing course resources of Sports Physiology; Secondly, based on the suggestions of educational technology experts, this article has developed a set of digital course resources, including interactive videos, virtual laboratories, and online self-test systems; Finally, the impact of new and old curriculum resources on student learning outcomes can be compared and analyzed through teaching experiments in experimental and control classes. From the perspective of student satisfaction, the majority of students scored above 4 points, with the highest reaching 5 points, indicating a high acceptance of adaptive learning systems. This study confirms the important value of digital teaching resources in improving the attractiveness and teaching effectiveness of higher education courses, and provides feasible solutions and empirical support for the development and optimization of physical education course resources in future universities.

1. Introduction

In the context of rapid development of information technology today, the development and application of digital educational resources have become an important trend in higher education reform. Especially in the field of physical education, the use of digital tools can greatly enrich teaching content and improve teaching effectiveness. However, the utilization of digital resources in physical education courses in universities, especially in the course of *Sports Physiology*, is still insufficient. In response to this issue, more and more research is focusing on how to integrate advanced digital technology into physical education teaching to improve the attractiveness of

courses and teaching quality. Related studies have shown that digital teaching resources can effectively improve students' learning motivation and participation, but research on course design and resource optimization in *Sports Physiology* is still scarce, highlighting the importance and urgency of in-depth research in this field.

The aim of this study is to design and implement an optimized curriculum resource for *Sports Physiology*, utilizing digital tools and methods to improve teaching efficiency and student learning outcomes. By integrating the latest digital technologies such as interactive videos, virtual laboratories, and adaptive learning systems, this study attempts to explore and validate the effectiveness of these tools in enhancing teaching interactivity and learning depth. In addition, the study can evaluate the effectiveness of these digital resources in practical teaching and their impact on students' understanding of complex physiological mechanisms through comparative experimental designs.

The research structure of this article is arranged as follows: Firstly, through literature review and needs analysis, the main problems and challenges in the use of existing teaching resources for the course of *Sports Physiology* can be identified. Then, based on these analyses, this article designs and develops a set of course resources that include various digital tools; Finally, actual teaching experiments can be conducted to compare and analyze the impact of new and old teaching resources on student learning outcomes, verifying the effectiveness and practicality of the developed resources. Through this study, the aim of this article is to provide theoretical basis and practical guidance for the digital transformation of physical education courses in universities, and to provide new perspectives and data support for the research and application of related educational technologies.

2. Related Work

In recent years, digital teaching resources have shown significant advantages in improving educational quality, especially in physical education courses. These resources effectively enhance students' learning motivation and participation by increasing interactivity and real-time feedback. Ning Ke used sports physiology as an example to study the improvement path of the teaching quality of basic theoretical courses in sports universities [1]. Yu Liang explored the ideological and political education in the course of *Sports Physiology*: significance, design, and practice [2]. Li Jianxin conducted an analysis of the current situation and influencing factors of college students' awareness of sports physiology knowledge in physical education teaching in universities [3]. Wang Xueqin studied the case design scheme for ideological and political education in the course of *Sports Physiology* [4]. Liu Ruilian explored the practical research on the testing and evaluation index system of teaching effectiveness based on project-based teaching method using the teaching of sports physiology as an example [5]. However, regarding the professional course of *Sports Physiology*, current research mainly focuses on the evaluation of the application effect of digital technology, and pays less attention to customized teaching content and methods based on the specific learning needs of students. This results in existing digital resources not fully meeting the personalized and in-depth learning needs of students.

As the core course of physical education in universities, *Sports Physiology* is crucial for sports majors to master the relevant physiological mechanisms. Wang Ao studied the application of the Nobel Prize in the teaching of "exercise physiology" [6]. Li Chuikun studied the teaching reform plan of sports physiology under the background of first-class courses [7]. Van Hooves K investigated whether wearable sweat lactate sensors can contribute to sports physiology research [8]. Hillen B studied infrared thermography in exercise physiology: the rise of exercise radiomics [9]. Karasievych S cultivated future physical education teachers to engage in sports activities from the

perspective of neuropsychological methods [10]. Although research has validated the effectiveness of digital teaching tools such as virtual laboratories and interactive simulations, these studies often overlook the systematic and scientific nature of instructional design, especially in integrating multiple teaching resources to meet the needs of different teaching stages, which still needs further exploration. In addition, there is a lack of research on the sustainability and long-term educational effects of these tools, which is an urgent issue to be addressed in future research.

3. Method

3.1 Design Concept and Requirements Analysis

In the design of digital teaching resources for *Sports Physiology*, a large amount of demand analysis was conducted and corresponding solutions were proposed. A survey was conducted on teachers and students in physical education teaching at various universities using methods such as online surveys and face-to-face interviews. This study mainly focuses on the current situation of using textbooks, the difficulties students encounter in the learning process, and the digital learning tools they hope to use. In addition, the research group also drew on relevant knowledge such as educational psychology and educational technology to ensure the scientific and practical nature of teaching resources.

The estimation formula for maximum oxygen uptake $VO2\ max$:

$$VO2\ max = 15.3 \times \left(\frac{HR_{max}}{HR_{rest}}\right) \tag{1}$$

Among them, HR_{max} is the maximum heart rate, and HR_{rest} is the resting heart rate. This formula helps evaluate an individual's cardiovascular endurance level and is crucial for the design of physical education courses.

3.2 Development of Interactive Video Teaching Content

The article's research group has developed interactive videos based on user needs. This tutorial covers the most important knowledge content in *Sports Physiology*, such as muscle contraction, cardiopulmonary function, etc. Each film is accompanied by animated demonstrations, live action videos, and professional commentary, ensuring the integration of theory and practice. At the same time, this course also features an interactive questioning session for students to take exams while watching, in order to deepen their understanding of the knowledge they have learned.

Calorie consumption formula:

$$C = MET \times 3.5 \times W \times T/200 \tag{2}$$

Among them, C represents total calorie expenditure, MET represents metabolic equivalent, W represents body weight, and T represents activity time. This formula can be used to calculate energy consumption under different exercise intensities, which is very useful for formulating reasonable exercise plans.

3.3 Construction of Virtual Laboratory

This study established a simulation experimental platform to enhance students' practical abilities in complex physiological mechanisms [11]. On this platform, students can conduct various physiological experiments, such as measuring blood pressure, gas, etc. This virtual laboratory adopts advanced drawing and simulation technology, allowing students to repeatedly conduct experiments and analyze and explain the experimental results. In addition, virtual experiments

provide timely feedback on incorrect operations, enabling students to learn from them.

3.4 Integration of Online Self-Test Systems

During the online self-testing process, this article provides with an online self-testing platform to assess the mastery of students' knowledge in *Sports Physiology*. This system includes various exam questions from beginner to advanced, covering various key points of this course. The testing system can automatically adjust the difficulty and type of the test questions based on the answers of the candidates, in order to achieve the goal of personalized teaching. In the backend of the system, by summarizing the answers of students, it helps teachers analyze their learning progress and understanding level.

The formula for the relationship between muscle strength and torque:

$$T = F \times d \tag{3}$$

Among them, T is the torque, F is the force, and d is the arm distance. This formula helps to understand how muscles generate torque through different lengths of force arms, which is crucial for designing exercises that effectively improve muscle strength.

3.5 Data Analysis and Intelligent Decision Support

This article adopts a method based on data analysis and intelligent decision-making to maximize the utilization of teaching resources. This article intends to conduct in-depth mining on the collected data through the analysis of video viewing duration, interactive Q&A responses, virtual experiment assignment paths, and other methods such as machine learning. By studying these issues, teachers can better understand the problems that students encounter in the classroom, thereby better guiding teaching. At the same time, the algorithm can also provide students with the most suitable learning resources based on their own learning methods and abilities, thereby achieving the goal of "teaching according to their aptitude."

Formula for heart rate recovery index:

$$HRI = HR_{peak} - HR_{1min} \tag{4}$$

Among them, HR_{peak} is the highest heart rate after high-intensity exercise, and HR_{1min} is the heart rate after one minute of recovery. Heart rate recovery rate is an important indicator for evaluating post exercise recovery ability and cardiovascular health.

3.6 Long-term Tracking and Feedback Mechanism

At the same time, the plan also establishes a long-term tracking and feedback mechanism to monitor the long-term utilization of teaching resources. The daily feedback and learning effectiveness tracking of students, combined with the observation and evaluation of teachers, enable the continuous optimization of digital teaching resources.

4. Results and Discussion

4.1 Teaching Effectiveness Verification Design

(1) Experimental layout and environmental preparation

In order to better understand the effectiveness of using digital teaching resources for *Sports Physiology*, the paper has carefully designed experiments to closely integrate each experiment with

the teaching content and individual characteristics of students, so as to better play its teaching role. The research object of this project covers various universities, aiming to improve the universality and practicality of research results through the diversification of samples. All experiments were conducted throughout a complete semester, aiming to comprehensively reflect the teaching effectiveness of digital resources throughout the entire *Sports Physiology* course.

(2) Parameter setting and recording

In order to accurately measure the learning effectiveness of students and the use of digital resources, the article has set a series of key parameters. These parameters include the initial knowledge level of students, the frequency of utilizing learning resources, the number of times interactive videos are watched, the degree of completion of virtual experiments, and the level of participation in online self-testing. To ensure the accuracy of the data and the reproducibility of the experiment, the article uses a learning management system to automatically record and analyze this data.

(3) Evaluation criteria and quantitative methods

When evaluating the effectiveness of digital teaching resources, the article used multiple dimensions and indicators. Firstly, the article evaluates students' mastery of knowledge and their knowledge growth after teaching through pre - and post tests. Secondly, it analyzes the frequency and depth of interaction between students and digital resources to evaluate their learning engagement. Once again, the article conducted a questionnaire survey to understand students' satisfaction and acceptance of these teaching resources. In addition, the article also quantifies the progress of students in practical operational skills through skill tests before and after virtual experiments. Finally, in order to evaluate the long-term memory effect of students on knowledge, it conducted a follow-up test one month after the end of the course.

The article used various statistical methods to quantify these indicators. For example, the article calculated the percentage of improvement in grades to visually demonstrate students' learning effectiveness, analyzed the trend of participation to evaluate students' learning attitudes, calculated the average score of satisfaction to reflect students' overall evaluation of teaching resources, and quantified students' improvement in operational skills through changes in skill test scores.

4.2 Result Analysis

(1) Analysis of the Impact of Interactive Videos

The impact analysis results of interactive videos are shown in Table 1.

Table 1: Analysis results of the impact of interactive videos

Student number	Group	Video type	Pre-test scores	Post test scores	Performance improvement
001	A	Standard video	65	75	10
002	A		72	80	8
003	A		68	76	8
004	A		70	78	8
005	A		66	74	8
006	B	Interactive video	64	82	18
007	B		71	85	14
008	B		69	83	14
009	B		67	81	14
010	B		65	80	15

Firstly, by observing the pre-test results, the average scores of the two groups of students are

similar, which means that their mastery of sports physiology knowledge is similar before the experiment begins. This provides a fair starting point for the subsequent comparative analysis.

Next, comparing the post test results, it can clearly see that the average score of the student group (Group B) using interactive videos is significantly higher than that of the student group (Group A) using standard videos in the post test. This indicates that interactive videos have more advantages in helping students understand and master knowledge.

Looking further at the magnitude of the improvement in grades, the average improvement in grades for students in group B was significantly higher than that of group A, which fully demonstrates the significant effect of interactive videos in promoting students' understanding of core physiological concepts. Interactive videos, through their unique interactivity and intuitiveness, provide students with a richer and more interesting learning experience, making learning more vivid and interesting, and easier for students to accept and understand.

Therefore, it can conclude that interactive videos have important value in improving student learning outcomes and are worthy of wider application in optimizing the design of physical education curriculum resources in universities.

(2) Practical testing of virtual experiments

The practicality test results of the virtual experiment are shown in Table 2.

Table 2: Practical test results of virtual experiments

Student number	Skill score before virtual experiment	Skill score after virtual experiment	Skill improvement score
001	60	85	25
002	65	88	23
003	70	90	20
004	68	86	18
005	62	83	21
006	72	92	20
007	67	89	22
008	64	87	23
009	71	91	20
010	69	88	19

Firstly, by observing the skill scores before the virtual experiment, it can see that the skill levels of students are roughly distributed between 60 and 72 points. This indicates that students have similar basic skill levels before the experiment begins, and there is still some room for improvement in this level.

Furthermore, the article noticed that after completing the virtual experiment, students' skill scores significantly improved. The skill scores of most students are concentrated between 83 and 92, which is a relatively high score range, indicating a significant improvement in their skill levels after virtual experiments.

From these data, it can conclude that virtual experiments are a highly effective teaching tool that can help students engage in practical operations in simulated environments, thereby deepening their understanding and mastery of sports physiology related skills. By participating in virtual experiments, students can try and practice multiple times without actual risks, thereby improving their skill level.

Therefore, in the optimization design of physical education curriculum resources in universities, it should fully utilize digital teaching resources such as virtual experiments to enhance students' practical operational skills. This not only helps to improve the learning effectiveness of students, but also lays a solid foundation for their future career development.

(3) Evaluation of the effectiveness of adaptive learning systems

The evaluation results of the adaptive learning system are shown in Figure 1.

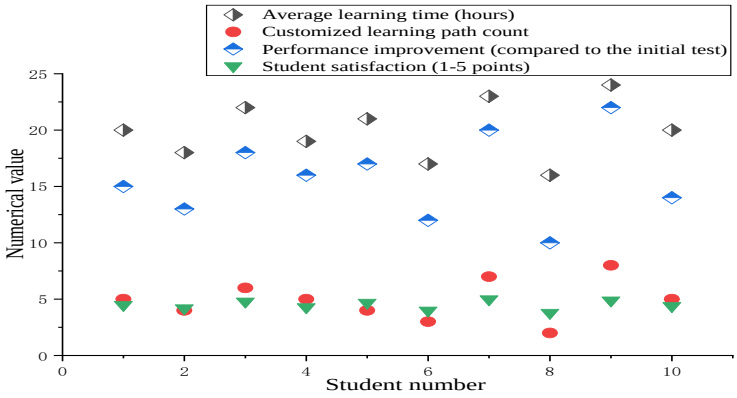

Figure 1: Performance evaluation results of adaptive learning system

Firstly, in terms of average learning time, students generally spend between 16 and 24 hours on adaptive learning systems, indicating their willingness to put in some effort and time for learning.

Secondly, the number of times a custom learning path can be observed, ranging from 2 to 8, indicating that the system can flexibly adjust according to the actual learning situation of students, providing personalized learning paths for each student. This flexibility is crucial for meeting the learning needs of different students.

Looking at the improvement in grades, each student's grades have improved significantly, with an average of 15.7 points. This indicates that adaptive learning systems can not only effectively help students improve their academic performance, but their effectiveness is significant.

Finally, in terms of student satisfaction, the majority of students scored above 4 points, with a maximum of 5 points, indicating a high acceptance of adaptive learning systems and satisfaction with this personalized learning approach.

Based on the above analysis, it can conclude that adaptive learning systems do provide effective personalized learning support for students. It can not only automatically adjust the learning path according to the learning situation of students, but also significantly improve their academic performance and receive widespread praise from students. Therefore, introducing such a system in the optimization design of physical education curriculum resources in universities is undoubtedly a wise choice.

(4) Comprehensive application experiment

The results of the comprehensive application experiment are shown in Table 3.

Table 3: Results of Comprehensive Application Experiments

Student number	Group	Usage of digital resources	Pre-test scores	Post test scores
001	A	Not used	65	72
002	A		70	77
003	A		68	75
004	A		66	74
005	A		72	79
006	B	Used	64	85
007	B		69	88
008	B		71	90
009	B		67	87
010	B		65	86

It can see that students are randomly divided into two groups, A and B. Group A students do not use digital resources, while Group B students use digital resources. By comparing the pre-test and post test scores of two groups of students, it can evaluate the teaching effectiveness of digital resources.

Firstly, observing Group A students, their academic performance improvement is relatively limited. For example, student ID 001 increased from 65 points in the pre-test to 72 points in the post test, an increase of 7 points.

Group B students utilized digital resources and achieved significant improvement in their grades. For example, student ID 006 soared from 64 points in the pre-test to 85 points in the post test, an increase of 21 points. The performance improvement of other students in Group B is also very high.

Through comparison, it can clearly see that Group B students who use digital resources have significantly better performance improvement than Group A students who do not use digital resources. This indicates that digital teaching resources have a significant impact on improving students' learning outcomes when used comprehensively. This experimental result strongly demonstrates the importance and effectiveness of digital teaching resources, and also provides strong support for us to apply digital resources more widely in teaching practice.

(5) Cross school comparison experiment

The cross school comparison experiment is shown in Figure 2.

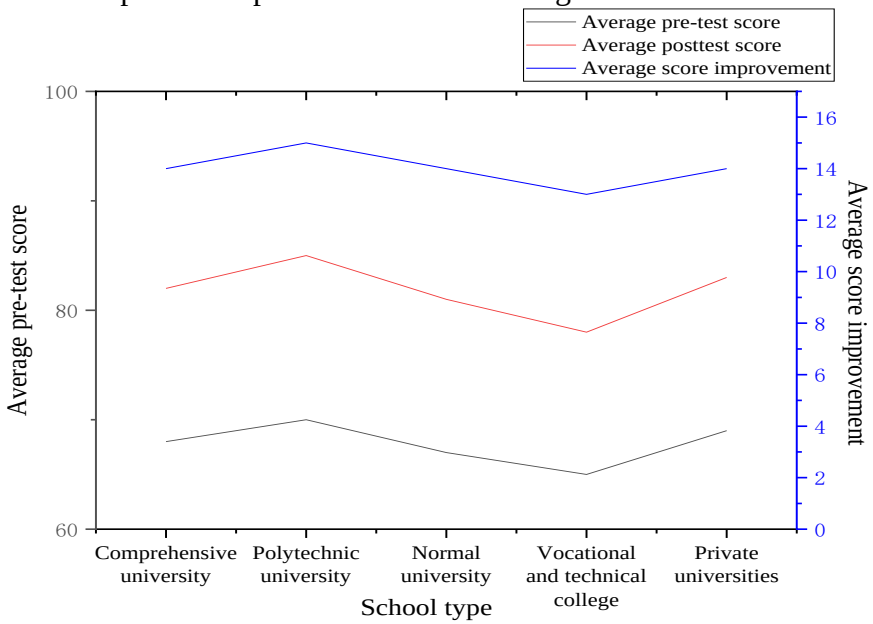

Figure 2: Cross school comparison experiment

It can observe differences in the effectiveness of different types of schools using the same digital resources for teaching. Firstly, the article noticed that all schools have chosen to use digital resources, which provides us with a fair basis for comparison.

From the average pre-test scores, the initial levels of students in various schools are similar, ranging from 65 to 70 points, indicating that the basic level of students in each school was equivalent before the experiment began.

Next, the article can focus on the indicator of average grade improvement. From the data, it can be seen that although the degree of improvement varies slightly among different schools, overall, it is between 13 and 15 points, indicating that digital resources have a universal effectiveness in improving student learning outcomes.

Finally, in term of the average post test score, the post test score of Polytechnic University is the

highest, reaching 85 points, which may be related to the learning ability of the students themselves or the teaching environment of the school. However, overall, the post test scores of each school have significantly improved compared to the pre-test, further verifying the positive role of digital resources in improving learning outcomes.

In summary, different types of schools can achieve certain improvements in teaching effectiveness when using the same digital resources, but the specific effects may vary depending on factors such as school type, student foundation, and teaching environment. This experimental result provides us with valuable reference and helps us better understand the application effects of digital resources in different teaching environments.

(6) Long term memory effect experiment

Student ID 1-5 uses digital resources, 6-10 does not use digital resources. The results of the long-term memory effect experiment are shown in Figure 3.

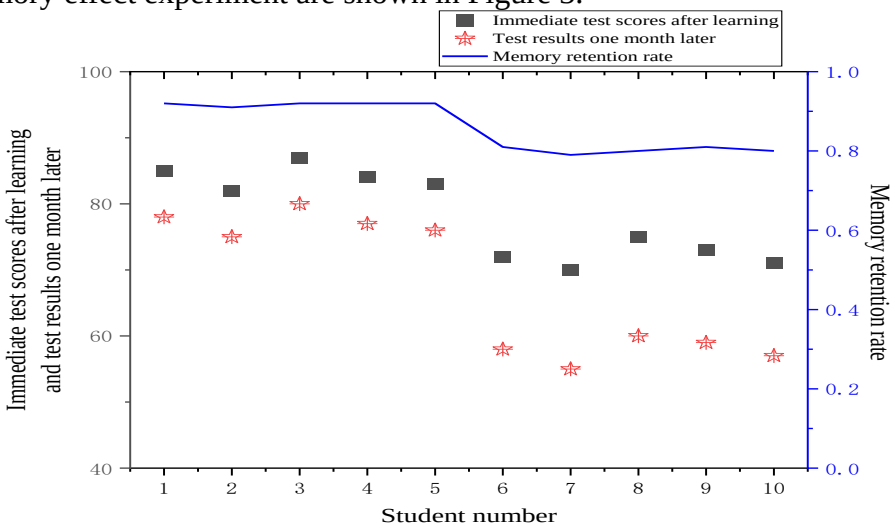

Figure 3: Experimental results of long-term memory effects

It can clearly see the important role of digital resources in the learning process of students. Firstly, the article focuses on the student population who use digital resources. They generally achieved higher scores in post learning instant tests, demonstrating the positive impact of digital resources on the immediate learning outcomes of students. It is worth mentioning that when these students took the test again a month later, although their grades decreased, their memory retention rate was generally above 90%. This fully demonstrates that digital resources not only help improve students' immediate learning outcomes, but also contribute to the maintenance of their long-term memory.

After comparing the student population who use and do not use digital resources, the article found a significant difference. Students who do not utilize digital resources tend to score lower on real-time tests. What's even more surprising is that they took the test a month later and found that their scores had dropped even more severely, and their memory was generally below 90%. This contrast highlights the importance of digital resources in improving student learning outcomes and long-term memory.

The results of this study further strengthen the significance of digital teaching resources for modern education. Multimedia courseware not only provides students with a large amount of learning materials, but also enables them to have an intuitive and vivid understanding and mastery of the content they have learned. This teaching method can not only play a good role, but also significantly enhance the storage capacity of students for long-term memory, laying a good foundation for future studies. Therefore, when optimizing the design of university physical

education teaching resources, it is necessary to fully tap their potential and maximize their effectiveness. By integrating and optimizing online resources, it can not only improve the quality of classroom teaching, but also create a more efficient and interesting learning atmosphere for students, allowing them to gain more joy and a sense of achievement in the learning process.

5. Conclusions

This article takes "*Sports Physiology*" as the research object and uses digital means and methods to comprehensively optimize the teaching resources in school physical education teaching. Based on previous research, this article aims to explore the role of digital teaching resources such as interactive videos, advanced virtual laboratories, and convenient online self-testing in improving student academic performance. On this basis, this study intends to adopt a complete set of control experiments, and based on this, comprehensively and meticulously evaluate the learning effectiveness of digital learning resources. The research results show that students who use the digital teaching resources people have developed have made significant progress in learning motivation, depth of knowledge understanding, and long-term memory retention. Especially in experimental groups that integrate multiple digital resources, students have significantly improved their theoretical knowledge mastery and experimental operation skills. In addition, the article conducted an in-depth analysis of the collected data, and the results showed that students had a very high acceptance and satisfaction with these digital teaching resources. This fully verifies the effectiveness and feasibility of digital tools in the teaching of *Sports Physiology*, and also makes us more convinced that digital education can provide students with richer, more vivid, and more efficient learning experiences.

Of course, the article’s research also has some limitations. Firstly, the samples mainly come from several different universities, which may to some extent limit the universality of the research results. Secondly, although the article tries to control the experimental conditions as much as possible, factors such as individual learning habits and technical proficiency of students may still have a certain impact on the experimental results. In addition, the evaluation time for long-term effects is relatively short, which may not fully reveal the comprehensive impact of digital resources on students' long-term learning outcomes. For future research, it can suggest further expanding the sample range to cover more students from different educational backgrounds and regions, in order to enhance the universality and representativeness of the research results. At the same time, it is also necessary to conduct long-term tracking research, which helps us to have a deeper understanding of the impact of digital teaching resources on students' long-term learning outcomes. In addition, with the continuous advancement of technology, it can explore more types of digital teaching tools and technologies in the future, such as augmented reality and virtual reality, to provide more diverse resources and means for the teaching of *Sports Physiology*. Through these efforts, the article looks forward to a more comprehensive evaluation and utilization of the potential application of digital technology in the field of physical education, creating more possibilities for students' learning and development.

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