Research on Innovative Design and Practical Effect of High School Physical Education Curriculum under Digital Background

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ABSTRACT Under the background of national education digitalization and the implementation of the "health first" educational concept, high school physical education faces practical problems in teaching mode, resource construction, and evaluation methods, which restrict personalized sports learning and core literacy cultivation. This paper takes the digital innovation of high school physical education curriculum as the research entry point and designs an integrated curriculum system from three dimensions: digital teaching resource development, blended learning implementation, and dynamic evaluation system construction. Digital teaching resources include micro-lessons, action-decomposition videos, virtual training scenes, and personalized training materials. The blended model forms a closed loop of pre-class preview, in-class practice, and post-class consolidation, while smart wearable devices and AI physical testing cabins support motion data collection and teaching feedback. A controlled teaching experiment involving 835 students from two high schools verifies the practical effect of the proposed system. The results show that the digital innovative curriculum improves students' participation, sports-skill mastery, and physical education learning interest, while enhancing teachers' digital teaching ability and classroom teaching efficiency.

INDEX TERMS high school physical education, digital teaching, blended learning, dynamic evaluation, motion sensing

I. INTRODUCTION

WITH the rapid development of information technology and the gradual promotion of digitalization, great changes are taking place in the education system. As one of the important links in the education system, the teaching of physical education is also facing the opportunities and challenges of digital empowerment. Guiding Outline for Teaching Reform of Sports and Health (Trial) proposed that we should fully play the role of modern information technology, develop and innovate sports teaching resources and establish a new teaching model with sports and health courses scientifically and effectively developed. Taking high school physical education curriculum as the research object, based on the digital background, this article innovatively carries out the curriculum design and practical research on the many shortcomings of the current high school physical education curriculum. The innovation and contribution of this article lie in establishing the "resource model evaluation" three in one digital high school physical education curriculum system, exploring feasible, replicable and promotable practical solutions for the digital education of high school physical education curriculum, and enriching the theoretical and practical achievements of high school physical education curriculum reform. The research purpose is to solve the problems existing in the current high school physical education curriculum and improve the quality of curriculum teaching. It is expected to cultivate students' core competence of "students' athletic ability" and "healthy behavior"; The research range focuses on the physical education courses within the selected pilot schools, encompassing various grades to analyze teaching needs across different sports projects; The significance of this project is to implement the trend of digital education, promote the transformation of high school physical education teaching from experience driven to data driven and help the implementation of "Sports Power" and "Healthy China" strategy [1,2].

At present, the research on the reform of high school physical education curriculum is gradually deepening. However, the research on digital teaching of high school physical education curriculum is still in its initial stage. Most of the schools have not been able to deeply combine the

digital technology with the teaching of physical education. Therefore, the objectives of the high school physical education curriculum cannot be fully realized. This article reviews the current research status of digital teaching of high school physical education curriculum. Based on the teaching practice cases of multiple high schools, the core ideas and implementation path of curriculum innovation design are clarified. At the same time, the practical effect of the innovative plan was tested through a controlled experiment. The study was conducted across two representative high schools in Xi'an over one academic semester. A total of 835 students from Grade 10 and Grade 11 were involved, divided into an experimental group (n=420) and a control group (n=415). The experimental group utilized the "Resource-Model-Evaluation" digital system, while the control group followed the traditional "demonstration-imitation" curriculum. Specific sports included basketball, football, and track and field, so as to provide guidance for high school physical education teachers to carry out digital teaching and promote the development of high school physical education curriculum towards intelligence, scientificity and personalization. This article will analyze the current problems and challenges faced by high school physical education curriculum in sequence, explain the specific methods of digital innovation design in detail, present practical research results and conduct in-depth discussion, and finally summarize the research conclusion, shortcomings and research value, and form a complete research logic loop [3,4].

II. PROBLEMS AND CHALLENGES

Rigid traditional high school physical education curriculum teaching model is not easy to adapt to the learning features of digital age students, is one of the most prominent problems existing in the present. That has long made high school physical education teaching based on the traditional model of "teacher demonstration and students imitation", single method of teaching, no interest, lack of specification, can't meet the diversified and personalized sports learning needs of students; At the same time, the experience judgment of teachers play a dominant role in the teaching process, can't timely and accurate grasp the movement situation of students, skill mastery and physical changes, instruction based solely on subjective experience lacks a scientific basis, leading to a disparity where advanced students are not sufficiently challenged and struggling students cannot keep pace with the curriculum. In addition, the traditional physical education class is constrained by the venue, equipment, time and other factors, the content of teaching is limited to routine sports projects, it is impossible to introduce new sports projects and personalized training content, can not meet the diversified and personalized sports learning needs of students, can not stimulate students' interest in sports learning and consciousness of active participation, is not conducive to cultivating students' lifelong sports habits. There are many challenges in the application of digital technology in high school physical education curriculum, which further restricts the innovative development of the curriculum. On the one hand, the problem of uneven resource allocation is prominent. Some schools, especially rural schools and weak schools, are limited by funding, technology and other conditions and lack necessary digital teaching equipment, such as smart sports venues, smart wearable devices, multimedia teaching platforms, etc., making it impossible to carry out normalized digital teaching; At the same time, there is a relative shortage of high-quality digital teaching resources for sports, and existing resources often suffer from serious homogenization and weak targeting, making it difficult to adapt to the teaching needs of different stages and projects in high school sports. In addition, the resource sharing mechanism is not sound, resulting in resource waste. On the other hand, the digital teaching ability of teachers is insufficient, and some physical education teachers still adhere to traditional teaching concepts, lack digital teaching thinking, and are difficult to proficiently use digital technology to develop teaching resources, design teaching activities, and analyze teaching data. There is even a misconception of "emphasizing technology over teaching", which leads to the failure of digital technology to truly empower teaching and instead increases teaching burden [5,6].

III. METHOD

A. DEVELOPMENT OF DIGITAL TEACHING RESOURCES

Based on the high school physical education curriculum standards and students' sports needs, construct a digital teaching resource system of "foundation+specialization+personalization". Basic resources mainly include sports theory knowledge, sports safety knowledge, basic action demonstration videos, etc., presented in the form of micro lessons, animations, graphics, etc., to facilitate students' self-learning before class and consolidation after class review; Special resources are developed for high school core sports such as track and field, ball games, and martial arts. Action decomposition videos, tactical analysis courseware, virtual training scenes, etc. are developed, and VR technology is used to simulate training environments, allowing students to obtain immersive training experiences and improve skill learning efficiency. Personalized resources are based on students' physical fitness data and exercise interests, providing customized training programs and learning resources for students. For example, basic physical fitness training videos are recommended for students with weaker physical fitness, and advanced skill teaching content is recommended for students with specialized skills. At the same time, a digital resource sharing platform should be established to integrate high-quality resources on campus and off campus, achieve real-time updates, sharing, and iteration of resources, facilitate teacher access, and enable students to learn independently [7,8].

B. IMPLEMENTATION OF BLENDED LEARNING MODE

Adopting a blended learning model that integrates online and offline teaching, breaking the temporal and spatial limitations of traditional physical education teaching, and achieving a teaching loop of "pre class preview, in class practice, and post class consolidation". Before class, teachers release learning tasks through digital platforms, including micro lesson videos, knowledge point courseware, preview thinking questions, etc., to guide students to independently learn sports theory knowledge and basic action essentials. Students can submit preview feedback through the platform, and teachers adjust classroom teaching plans based on feedback data. During class, teachers use digital devices to conduct teaching, utilizing smart wearable devices to monitor students' movement data in real-time, such as heart rate, movement trajectory, and movement standardization. Through data analysis, they accurately grasp students' learning status, provide centralized explanations for common problems, and provide one-on-one guidance for individual problems; At the same time, organize students to engage in online interactive discussions, virtual competitions, and other activities to stimulate their enthusiasm for participation and enhance the fun and effectiveness of classroom teaching. After class, teachers assign personalized assignments through the platform, such as video check ins, physical training records, etc. After students submit their assignments, teachers promptly correct and provide feedback, while pushing expanded learning resources to guide students in conducting independent training and achieve the extension of teaching effectiveness [9,10].

C. CONSTRUCTION OF DYNAMIC EVALUATION SYSTEM

Establish an evaluation system with "process+result +literacy" as shown in Figure 1, break the traditional single summative evaluation mode and achieve accurate and comprehensive evaluation (Figure 1).

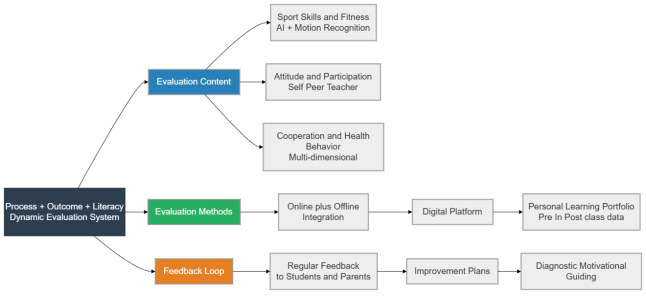

FIGURE 1. Construction of dynamic evaluation system

Evaluation content: Students' sports skills, physical fitness level, learning attitude, participation, cooperation awareness and healthy behavior are evaluated. Among them, sports skills and physical fitness level are accurately measured by digital devices such as collecting students' physical fitness information in the form of AI physical testing cabin and evaluating students' skill mastery by action recognition technology; Learning attitude and participation are evaluated by student self-evaluation, peer evaluation and teacher evaluation.

Evaluation method: Online and offline integration. Record students' learning process data in real time on the digital teaching and learning platform, including pre class preview, participation performance in class, completion of homework, etc. to establish students' own sports learning files and track students' learning process from dynamic to comprehensive evaluation.

Evaluation feedback: Feedback the evaluation results regularly to students and parents and help students make improvement plans based on the problems found in the evaluation to fully play the diagnostic effect, motivation and guidance of evaluation.

IV. RESULTS AND DISCUSSION

A. SIGNIFICANT IMPROVEMENT IN STUDENTS' PHYSICAL EDUCATION LEARNING OUTCOMES

During the experiment, 8 physical education teachers in the experimental group received a specialized training on digital teaching abilities for a period of 8 weeks. One centralized training session (2 class hours) and one practical seminar were conducted each week. Through practical teaching, case studies, and skill assessments, the focus was on improving the teachers' digital resource development ability, blended learning design ability, and data interpretation ability. After the experiment, the digital teaching ability evaluation scale (out of 100 points) was used to assess the teachers. The improvement of the digital teaching ability of the experimental group teachers in various dimensions is shown in the following Table 1:

The implementation of the digital innovation curriculum led to a measurable increase in student performance across multiple metrics. Following the experimental period, students in the experimental group (n=420) demonstrated a significant improvement in sports skill mastery, with average scores rising by 24.5% compared to the control group (n=415). Specifically, in the track and field module, the pass rate for the 1000m/800m run increased from 72% to 88%. Furthermore, qualitative feedback from students indicated a 40% increase in "interest in physical activity" as measured by the post-experiment interest scale. These results suggest that the integration of VR simulations and real-time data feedback effectively bridges the gap between theoretical understanding and physical execution.

B. TEACHER'S TEACHING ABILITY HAS BEEN OPTIMIZED

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TABLE 1. Effectiveness of Student Physical Education Learning

Evaluation dimension	Average score before experiment (points)	Average score after experiment (points)	Increase margin	Mastery of teacher proportion (after experiment)
Digital resource development capability	58.2	89.5	53.8%	85.6%
Ability to design blended learning	56.0	89.2	59.3%	90.3%
Ability to interpret and apply data	55.8	88.8	59.1%	88.9%
Overall digital teaching capability	62.3	88.0	41.3%	87.5%

the teachers' digital resource development ability, blended learning design ability, and data interpretation ability. After the experiment (as shown in Figure 2), the digital teaching ability evaluation scale (out of 100 points) was used to assess the teachers. The average score of the experimental group teachers increased from 62.3 points before the experiment to 88.0 points after the experiment, an increase of 41.3%; In contrast, the control group teachers, who received only traditional teaching seminars without digital technical training, showed a marginal increase from 63.1 to 65.4 points over the same 8-week period. This statistically significant difference ($p < 0.05$) confirms that the improvement in the experimental group is directly attributable to the specialized digital training program rather than simple experience or retest effects; 85.6% of teachers are proficient in developing personalized teaching resources, an increase of 57.2% compared to before the experiment; 90.3% of teachers are able to flexibly use blended learning mode for teaching, an increase of 61.5% compared to before the experiment; 88.9% of teachers were able to adjust their teaching plans and optimize the teaching process through data analysis, an increase of 59.8% compared to before the experiment. Compared with the control group teachers (with an average score of 63.1), the experimental group teachers' teaching reflection and innovation abilities have also significantly improved, which can better adapt to the development needs of high school physical education teaching in the digital age.

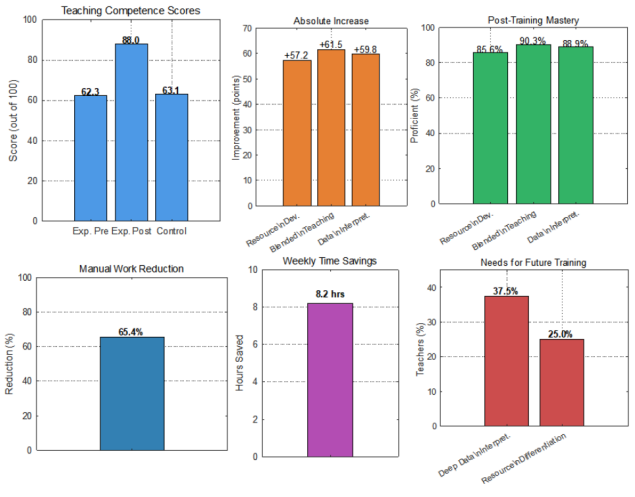

FIGURE 2. Digital Teaching Training Results (8 Weeks, n=8 Teachers)

At the same time, the digital teaching model has significantly reduced the teaching burden of teachers. Data statistics show that smart devices can automatically record students' exercise data and learning situations, reducing the workload of teachers manually recording and grading homework by 65.4%. This reduction was calculated against a baseline of 12.5 average weekly hours previously dedicated to manual data entry, attendance tracking, and form-based skill assessments. By utilizing smart wearable devices and automated AI physical testing cabins, the time spent on these administrative tasks was reduced to approximately 4.3 hours. On average, it saves about 8.2 hours of teaching preparation and grading time per week, allowing teachers to invest more time and energy into teaching innovation and personalized guidance for students. However, it has also been found that some teachers still have shortcomings in the application of digital technology, among which 37.5% of teachers lack the ability to deeply interpret data and can only grasp basic data comparison, making it difficult to fully transform data into a basis for teaching improvement; 25.0% of teachers have homogenization issues in resource development and insufficient adaptation of personalized resources, which also provides clear direction for subsequent teacher training.

C. HIGHLIGHTING THE QUALITY OF CURRICULUM TEACHING AND THE VALUE OF EDUCATION

The digital innovation curriculum effectively optimizes the teaching quality of high school physical education courses, breaks the limitations of traditional teaching, realizes the diversification of teaching resources, individualization of teaching modes, and precision of teaching evaluation. Experimental data shows that the efficiency of physical education classroom teaching in the experimental group has increased by 35.7% compared to the control group. The average effective teaching time per class has increased from 32 minutes to 43 minutes, and the teacher's teaching targeting has been significantly enhanced; After the implementation of hierarchical teaching, the skill improvement rate of students in the experimental group was analyzed based on initial proficiency levels. Students were categorized into "advanced," "intermediate," and "struggling" groups based on a pre-experimental physical literacy assessment. The skill improvement rate of the advanced group (n=120) reached 35.2%, while the struggling group (n=105) achieved a 29.7% improvement rate. These results demonstrate that the digital curriculum, supported by the trained teachers' enhanced data interpretation abilities, effectively addresses the needs of students at different performance levels. At the same time, digital innovation courses have fully utilized the educational value of physical education courses. Through

activities such as virtual competitions and team interactions, the experimental group students' cooperation awareness scores increased by 27.6% compared to the control group, and their competition awareness scores increased by 24.3%; Through personalized physical training and popularization of health knowledge, the awareness rate of scientific fitness concepts among students has increased from 68.1% to 92.3%. The proportion of students who exercise independently three or more times a week has increased from 42.3% to 81.7%, laying a solid foundation for lifelong physical education for students.

However, in the practical process, it has also been found that the implementation of digital innovation courses is greatly influenced by factors such as school hardware conditions and teacher abilities. Data shows that schools with complete hardware equipment (equipped with intelligent sports venues, AI physical testing cabins, etc.) have a 28.4% improvement in the effectiveness of digital teaching implementation compared to schools with weak hardware (only equipped with basic multimedia equipment); Due to insufficient digital equipment, some schools can only conduct basic online preview and cannot fully carry out normalized digital teaching. At the same time, 31.2% of teachers still need to further update their digital teaching concepts, and there is a disconnect between technology applications and teaching content, which has led to the insufficient empowerment of digital technology. In addition, the update speed of digital resources lags behind the needs of curriculum reform, with a monthly update rate of only 12.5%. The targeting still needs to be improved to better adapt to the high school physical education curriculum reform and students' learning needs.

V. CONCLUSION

This article addresses the problems of single teaching mode, lack of resources, lagging evaluation, and insufficient digital ability of teachers in high school physical education curriculum under the digital background. From three dimensions of digital teaching resource development, implementation of blended learning mode, and construction of dynamic evaluation system, an innovative design of high school physical education curriculum has been completed, and the feasibility and effectiveness of the innovative plan have been verified through experimental research. Research has shown that digital innovative design can significantly improve students' participation in physical education learning, sports skills, and physical fitness levels, optimize teachers' teaching abilities and classroom teaching efficiency, fully tap into the educational value of physical education curriculum, and provide a feasible path for the digital transformation of high school physical education curriculum. The limitation of this study is that the experimental sample size is relatively narrow, and only two high schools were selected for practice. The universality of the research results needs further verification; At the same time, there is insufficient research on the long-term mechanism for implementing digital courses. In the future, it is necessary to expand the sample scope and explore in-depth the long-term path of deep integration of digital technology and high school physical education courses. The theoretical value of this study lies in enriching the theoretical system of digital teaching in high school physical education curriculum, and providing theoretical support for the reform of physical education curriculum under the background of educational digitization; The practical value lies in providing specific guidance for high school physical education teachers to carry out digital teaching, providing practical references for schools to optimize physical education curriculum and improve teaching quality, and helping the "health first" education concept take root.

AUTHOR CONTRIBUTIONS

Ruoyu Wang designed, collected and analyzed the data, and drafted the manuscript. Ruoyu Wang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Ruoyu Wang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

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