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Research on AI-Empowered "Three-Dimensional, Four-Drive" Smart Teaching Model for Public Physical Education in Higher Education Institutions

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Abstract: University public physical education has several chronic issues: similar teaching objectives, extensive process management, single-dimensional evaluation, and insufficient intrinsic motivation. The AI-empowered "three-dimensional four-drive" smart teaching model addresses these challenges by focusing on three dimensions—teaching objectives, teaching process, and teaching evaluation—and leveraging four driving forces: data-driven, model-driven, knowledge-driven, and demand-driven. This establishes a full-cycle closed-loop teaching system. Supported by intelligent software and hardware, precise implementation across stages, synergistic iteration of the four drives, and optimized supporting measures, physical education can transition from experience-based to precision-oriented approaches, systematically enhancing teaching effectiveness.

Keywords: Artificial Intelligence; Physical Education; Three-Dimensional Four-Drive; Data-Driven; Intelligent Teaching

Introduction

Higher education public physical education has long faced several structural issues: similar objectives, lax process management, single-dimensional evaluation criteria, and insufficient intrinsic motivation. Artificial intelligence offers new pathways to address these challenges. By integrating the four driving mechanisms—data-driven, model-driven, knowledge-driven, and demand-driven—into a framework centered on the three dimensions of teaching objectives, processes, and evaluation, a "three-dimensional, four-driven" smart teaching model emerges. Further implementation through four layers—software and hardware support, segmented implementation, closed-loop collaboration, and complementary safeguards—enables physical education to shift from an experiential approach to a precise one, achieving systematic transformation.

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1. Definition of Core Concepts and Underlying Architectural Patterns

1.1 Core Interpretation of the Three-Dimensional Framework in College Public Physical Education Teaching

This study encompasses three dimensions: the teaching objectives dimension, the teaching process dimension, and the teaching evaluation dimension. Together, these three dimensions cover the entire cycle of public physical education in higher education, from pre-class preparation to in-class implementation and post-class feedback. The teaching objectives dimension sets the direction and level of talent cultivation, providing value guidance for the entire teaching activity. The teaching process dimension manages the teaching organization and implementation in classroom practice, ensuring the orderly progression of teaching activities. The teaching evaluation dimension systematically assesses teaching effectiveness to determine whether the objectives have been achieved. These three dimensions are interlinked, forming a closed-loop logic for teaching reform that drives the overall optimization of physical education at the structural level [1].

1.2 Core Interpretation of the Four-Drive Dynamic Mechanism in University Public Physical Education Teaching

The four driving mechanisms defined in this study include four core forces: data-driven, model-driven, knowledge-driven, and demand-driven. These four elements interact dynamically to form a closed-loop power system necessary for the operation of the teaching system. Data-driven mechanisms provide objective foundations for teaching decisions and process adjustments, ensuring that teaching behaviors are based on measurable and quantifiable information. Model-driven mechanisms standardize the pathways and procedures of teaching operations, ensuring that teaching activities are stable and controllable. Knowledge-driven mechanisms reinforce the professional theories and skills required for teaching, enhancing its scientific depth. Demand-driven mechanisms continuously calibrate the direction of teaching optimization, providing clear and targeted improvements. Together, these four forces work in concert to sustain the continuous operation and iteration of the teaching system.

1.3 Artificial Intelligence Empowers the Adaptation Logic of the Three-Dimensional Four-Drive Model

The integration of artificial intelligence technology with three teaching dimensions covers all aspects of the entire teaching cycle, while relying on four driving mechanisms to provide systematic power input for teaching operations. This adaptation effectively addresses the shortcomings in traditional university public physical education, such as homogeneous goals, extensive process management, single evaluation dimensions, and insufficient internal motivation. Empowered by technology, the three dimensions can operate in synergy, and the four driving forces form a closed-loop feedback system, ultimately establishing a specialized physical education system. Supported by technology, this system is characterized by interconnected dimensions as its structural feature and closed-loop dynamics as its operational mechanism, thereby enhancing the overall teaching efficiency.

2. Existing Pain Points and Causes in the Operation of Public Physical Education in Traditional Higher Education Institutions

2.1 Existing Issues in the Operation of Traditional Three-Dimensional Teaching Processes

The stratification of teaching objectives is insufficient, making it difficult for uniformly set goals to match the individual differences among students in physical fitness levels, sports foundations, and athletic literacy. This results in a mismatch between the starting point of instruction and students' actual abilities. Additionally, the teaching process dimension lacks sufficient interaction and precision. Key aspects such as movement correction, physical training arrangements, and group-based instruction rely primarily on manual efforts, causing teaching interventions to consistently lag behind students' learning progress, preventing timely and effective guidance. Furthermore, teaching evaluation predominantly relies on summative assessments, with limited use of formative data from the learning process. Consequently, evaluation outcomes are less objective in reflecting the true effectiveness of instruction, making it challenging to comprehensively capture students' developmental trajectories.

2.2 Absence of Four Driving Force Mechanisms in Traditional Physical Education

The collection of learning data is piecemeal and lacks a systematic data-driven mechanism to support dynamic adjustments and optimizations in the teaching process. Due to the absence of standardized instructional algorithm models, teaching activities rely primarily on teachers' subjective experiences, resulting in significant differences in teaching behaviors among different teachers. The integration of specialized sports knowledge and learning analysis knowledge in physical education is relatively low, and the empowering potential of knowledge-driven approaches in teaching is insufficient, unable to provide adequate knowledge support for teaching decisions [2]. Students' needs for personalized sports learning and physical fitness enhancement have not become the core focus of teaching, and the guiding role of demand-driven approaches is essentially absent, leading to a disconnect between teaching directions and learning demands.

2.3 Shortcomings in Adaptability of Artificial Intelligence Integration in Physical Education

Most smart devices currently used in sports teaching have only a single function of physical fitness detection and are not integrated with the comprehensive system of teaching. The application of technology is fragmented, overlooking the inherent connections between teaching objectives, teaching processes, and teaching evaluations. The four driving mechanisms operate independently without forming a closed-loop synergy. Additionally, the smart technology application capabilities of teaching subjects are insufficient. The integration of technology and classroom teaching remains superficial, failing to truly stimulate and reshape the underlying operational model of sports education. As a result, the intended empowering effects of artificial intelligence are not realized. Despite significant technological investments, actual improvements in teaching fail to keep pace, creating a noticeable gap.

3. Construction of a Three-Dimensional Four-Drive Intelligent Teaching Model Empowered by Artificial Intelligence

3.1 AI-Empowered Full-Cycle Transformation and Construction of 3D Teaching

In the dimension of teaching objectives, artificial intelligence reconstructs the teaching objectives into different tiers based on students' baseline physical fitness data. The originally unified objectives are broken down into three levels: basic physical development, specialized skill mastery, and sports literacy enhancement. This makes it clearer for students with different starting points to determine which direction they should progress toward. In the dimension of the teaching process, visual recognition and posture capture technologies are used to optimize classroom intelligent management processes, enabling automatic movement correction, real-time regulation of exercise load, and precise arrangement of group teaching. As a result, the responsiveness and efficiency of the teaching process are enhanced. In the dimension of teaching evaluation, a multi-source verification system is established, integrating classroom behavioral performance, physical fitness test data, and self-training records. Evaluation runs through the entire teaching process, assessing performance in a quantitative manner[3].

3.2 Empowering the Four-Wheel Drive Closed-Loop Power Mechanism with Artificial Intelligence

At the data-driven level, a comprehensive foundation of student data is established by using intelligent collection terminals to fully gather students' physical fitness status, classroom performance, and training activities. This creates a complete data baseline. At the model-driven level, specialized algorithm models for evaluating physical education learning and adapting sports training are developed. These models standardize the specific pathways of teaching implementation, ensuring a structured and systematic teaching process. At the knowledge-driven level, professional knowledge bases such as exercise physiology, physical education pedagogy, and physical fitness intervention are integrated to provide a solid knowledge foundation for the scientific implementation of teaching activities. At the demand-driven level, students' diverse needs—such as improving physical fitness, mastering specific sports skills, and cultivating health literacy—are clarified, which in turn helps calibrate and adjust the direction of teaching. These four driving mechanisms are interdependent and together form a closed-loop dynamic system, continuously injecting momentum into the teaching process.

3.3 Establishment of the Integrated Mode Framework Empowered by Three-Dimensional Linkage and Four-Drive Synergy

This model utilizes four driving mechanisms as the underlying operational force, with three dimensions—from goal setting to classroom instruction and assessment evaluation—running throughout the entire process. By linking goal adaptation, instructional implementation, evaluation feedback, and motivation iteration, each stage can be seamlessly connected. Artificial intelligence plays a crucial role here, enabling evaluation results to refine teaching objectives and dynamically adjust instructional pathways, thereby realizing the guiding effect of evaluation on both goals and processes. Under this framework, the three dimensions of teaching objectives, teaching processes, and teaching evaluation interact and reinforce one another, while the four driving mechanisms operate in concert. Ultimately, this establishes an integrated smart teaching system featuring three-dimensional collaboration and synergistic four-drive dynamics, allowing physical education to achieve systematic operation and continuous improvement at an advanced level.

4. Implementation Pathways for the AI-Empowered 3D Four-Drive Teaching Model

4.1 Build a Smart Teaching Software and Hardware Support System Compatible with Mode-based Operation

To make the smart teaching model operate regularly, it is first necessary to establish a unified campus public sports data platform. This platform integrates smart hardware devices such as posture recognition, heart rate and load monitoring, and venue perception, and then links them with the sports teaching algorithm platform. By opening up the data exchange ports among the three stages of teaching objectives, teaching processes, and teaching evaluation, information can flow smoothly between different stages. Furthermore, the standards for data collection across the four driving mechanisms should be unified, enabling data-driven, model-driven, knowledge-driven, and demand-driven approaches to work on the same data foundation. Once this technological foundation is established, it provides stable software and hardware support for the model's operation, ensuring complete data collection and efficient transmission throughout the entire teaching process, thereby solidifying the technical foundation of the smart teaching system [4].

4.2 Refining the Intelligent Implementation Process of Three-Dimensional Teaching by Phase

Before class, first assess students' learning conditions using four key driving mechanisms. Review data on students' physical fitness, athletic foundation, and learning preferences, then set tiered goals accordingly. Before class, first assess students' learning conditions using four key driving mechanisms. Review data on students' physical fitness, athletic foundation, and learning preferences, then set tiered goals accordingly. For students with weaker foundations, focus on physical conditioning and fundamental movements; for those with stronger foundations, advance toward specialized skills and overall sports literacy. This approach ensures that goals align more closely with each student's actual situation. During class, use smart devices to monitor students' exercise load—tracking heart rate, intensity, and movement accuracy in real time. The devices can also help standardize techniques by providing timely reminders and corrections when movements are incorrect. By tailoring instruction to individual differences—students with better fitness work more on technique, while those with weaker fitness build foundational skills—the precision of teaching improves, avoiding a one-size-fits-all approach. And the lesson doesn't end when class is over. The platform collects data from students' independent practice after class, recording whether they practiced, how much, and how well they performed. For students with weaker foundations, focus on physical conditioning and fundamental movements; for those with stronger foundations, advance toward specialized skills and overall sports literacy. This approach ensures that goals align more closely with each student's actual situation. During class, use smart devices to monitor students' exercise load—tracking heart rate, intensity, and movement accuracy in real time. The devices can also help standardize techniques by providing timely reminders and corrections when movements are incorrect. By tailoring instruction to individual differences—students with better fitness work more on technique, while those needing improvement build foundational skills—the precision of teaching increases, avoiding a one-size-fits-all approach. And the lesson doesn't end when class is over. The platform collects data from students' independent practice after class, recording whether they practiced, how much, and how well they performed.

4.3 Optimizing the Closed-loop Cooperative Operation Mechanism of Four-wheel Drive Power

To ensure the four driving mechanisms form a stable closed-loop synergy, it is essential to establish a dynamic iteration mechanism. Continuously updated teaching data should be used to iteratively upgrade the analysis model, ensuring data-driven approaches remain sensitive to real learning conditions. By leveraging specialized knowledge bases to optimize the computational logic of model-driven systems, the model's ability to standardize teaching pathways can be enhanced. Based on students' evolving learning needs, the dimensions and priorities of data collection should be adjusted in a timely manner, allowing demand-driven approaches to accurately reflect the direction of teaching optimization [5]. Throughout this process, the four driving forces balance each other, preventing any single force from operating in isolation or dominating excessively. Through continuous iteration and coordinated cooperation, these four driving forces can dynamically adapt to changes in students' learning conditions, ensuring the adaptability and stability of the teaching model and forming a well-functioning closed-loop dynamic system.

4.4 Enhancing Teaching Support Optimization Measures to Improve Model Operation

To ensure the smooth operation of the smart teaching model, supporting measures must be aligned in three areas: faculty capabilities, venue allocation, and mechanism iteration. In terms of faculty capabilities, it is essential to enhance the smart teaching application skills of public physical education teachers in universities. This can be achieved by organizing specialized teaching and research activities focused on sports intelligent technology operation and learning data analysis, enabling teachers to gain a deeper understanding of the model and improve their implementation proficiency. Regarding venue resources, the class scheduling mechanism for public smart sports facilities should be optimized to align with the practical needs of stratified teaching and minimize resource conflicts [6]. In mechanism development, an internal iterative adjustment mechanism for the model should be established. Based on feedback from teaching operations, specific details of the three teaching stages should be promptly refined, and the operational parameters of the four driving mechanisms should also be adjusted accordingly.

Conclusion

The AI-powered "Three-Dimensional Four-Drive" smart teaching model, structured around the three dimensions of teaching objectives, teaching process, and teaching evaluation, leverages the four driving mechanisms—data-driven, model-driven, knowledge-driven, and demand-driven—to systematically address the structural issues inherent in traditional physical education. These issues include homogenized objectives, coarse process management, singular evaluation methods, and insufficient motivation. With measures such as a software and hardware support system, segmented intelligent implementation, four-drive closed-loop coordination, and optimized supporting safeguards, the entire teaching cycle achieves precise operation and continuous improvement. This provides a practical and systematic pathway for transitioning university public physical education from an experience-based approach to a precision-oriented one.

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