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Triple Dimensions of Precision Teaching in Physical Education under the "Four New" Initiatives Framework: Mechanism Development, Current Bottlenecks, and Pathway Innovations

Wensu Dong[1], Rui Liu[2], Shuyong Liu[1]*
[1]Harbin Normal University, Harbin 150025, Heilongjiang, China
[2]Lingnan Normal University, Zhanjiang 524048, Guangdong, China

**Author to whom correspondence should be addressed.*

Abstract:

To accelerate educational modernization and address unprecedented global challenges, the Central Committee of the Communist Party of China has introduced the "Four New" policy framework. In physical education, this translates to leveraging multimodal data and advanced technologies to achieve precision teaching, a critical strategy for advancing national education and sports development. This study employs a problem-cause-solution analytical framework to systematically explore the mechanism construction, practical constraints, and innovative pathways of data-driven precision teaching in physical education. Key findings indicate: (1) Mechanism construction requires establishing an integrated data-driven platform that enables closed-loop workflows spanning real-time data collection, AI-powered analytics, and adaptive feedback delivery; (2) Practical constraints stem from multifaceted challenges including poor data quality (low signal-to-noise ratios), resistance to technology-integrated pedagogy, inadequate teacher technological competency, ethical dilemmas in sensitive data handling, and fragmented data ecosystems—all systematically deconstructed through causal analysis; (3) Innovative pathways propose a four-pillar solution framework: technological augmentation (e.g., multi-camera AI vision, edge computing), pedagogical transformation (e.g., dynamic grouping, competency-based progression models), systemic resource orchestration (e.g., federated learning platforms, interoperable cloud architectures), and institutional safeguards (e.g., tiered data governance protocols, AI ethics guidelines). This multidimensional approach not only addresses current implementation barriers but also provides a scalable model for aligning precision teaching with the strategic objectives of the "Four New" initiatives, ensuring both educational efficacy and technological sustainability in the digital era.

Keywords:

"Four New" initiatives
Data-driven education
Precision physical education
Educational modernization

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1. Introduction

Entering the third decade of the 21st century, the global education system has undergone a profound transformation from traditional models to intelligent and precision-based approaches, driven by modern information technology. Since the 19th National Congress of the Communist Party of China, the central leadership, with the General Secretary at its core, has placed great emphasis on interdisciplinary integration and the cultivation of innovative talent. The "Four New" Initiative—New Engineering, New Medicine, New Agriculture, and New Humanities—has been proposed as a strategic framework to enhance national competitiveness through educational modernization. As a crucial component of holistic education, sports education urgently needs to break away from the limitations of the traditional "one-size-fits-all" teaching model. By leveraging data-driven teaching, precision and intelligence-driven reforms can be realized, facilitating the deep integration of science, technology, and educational principles [1].

In 2018, the Ministry of Education issued the "Education Informatization 2.0 Action Plan," which focuses on the new demands of talent cultivation in the digital era. It recognizes educational informatization as an inherent variable driving systemic transformation and advocates for the deep integration of information technology with teaching. This initiative provides theoretical guidance and policy support for the transition of sports education from "experience-based instruction" to "data-driven empowerment." Precision teaching, driven by data, enables real-time collection and analysis of students' multidimensional data, allowing for dynamic adjustments to teaching strategies, thus enhancing instructional efficiency and promoting health.

However, the current development level of sports informatization, digitization, and intelligent education in China still falls short of the strategic goals outlined in the "14th Five-Year Plan for Sports Development," the "Outline for Building a Leading Sports Nation," and the "Healthy China 2030 Plan." Significant bottlenecks remain in areas such as data collection, feedback mechanisms, and evaluation systems, limiting the potential of precision teaching in improving athletic skills and promoting overall health development [2].

2. The coupling logic of the "Four New" construction and the digital transformation of education

2.1. Connotation deconstruction

In April 2021, when visiting Tsinghua University, the General Secretary clearly pointed out the requirements of promoting the construction of new engineering, new medical science, new agricultural science, and new liberal arts (referred to as the "four new" construction), aiming at the world's scientific and technological frontiers and the national strategic needs, speeding up the cultivation of talents in short supply, and promoting the change of China's higher education paradigm. As a specific projection of the national innovation-driven development strategy in the field of education, the "Four New" construction presents multi-dimensional characteristics: new technology (5G/AI/VR), new basis (data-driven decision-making), new industry (integration of sports and education), new industry (sports science and technology services), which constitutes a four-in-one sports precision teaching model (see **Figure 1**). New technology empowers the intelligentization of sports teaching, new basis helps teachers to make faster and better decisions, new industry promotes the integration of physical education and the development of the integration of industry and education, and new industry realizes the sports science and technology service, which jointly promotes the transformation of sports teaching from the judgment of experience to the decision-making of data, from the teaching of groups to the individual adaptation, and from the static evaluation to the dynamic optimization, providing a new path and example for the modernization of physical education and relying on the experience of teachers and the management of groups, and it is difficult to take into account the individual difference of the traditional physical education. It also injects new vigor and possibilities into traditional physical education, which relies on teachers' experience and group management and is difficult to take individual differences into account [3].

Figure 1. Precision teaching in physical education

2.2. Opportunities for transformation

The evolution of physical education teaching mode can be roughly divided into three stages. In the early days, the "one-size-fits-all" teaching mode emphasized uniform standards and collective activities, ignoring individual differences, resulting in students' low participation and obvious deficiencies. With the continuous progress of the concept of education, layered teaching gradually emerged, and teachers began to group teaching according to students' physical fitness and athletic ability, and strive to achieve hierarchical and targeted training. However, tiered teaching still has problems such as inconsistent evaluation standards and untimely adjustments in practice, making it difficult to fully reflect the true level and progress of students [4].

In the wave of global digital transformation, China's physical education has ushered in unprecedented development opportunities (see **Figure 2**), and policies have been intensively introduced at the national level, such as the "Outline for the Construction of a Strong Sporting Nation," the "14th Five-Year Plan for the Development of Physical Education," the "Healthy China 2030" Plan, and the Outline of the Plan for the Construction of a Strong Education Nation (2024–2035) all emphasize the need to accelerate the digital transformation of education, promote the in-depth integration of modern information technology and physical education teaching, and make the data-driven precise teaching mode gradually become a new direction for physical education reform. At the same time, the rapid development of information technology provides realistic feasibility for the practice of precision teaching in physical education. Numerous studies have shown that sports games (Exergames) or smart wearable devices developed based on the new generation of information technology have intrinsic motivational effects on clinical and non-clinical populations, regulate their negative emotions, and have a significant impact on their attention, motor skill development, etc. [1], which is a valuable step for subsequent large-scale application and promotion. Artificial intelligence and big data analysis can achieve personalized exercise program customization, smart wearable devices can monitor students' exercise status in real time, virtual reality (VR) technology provides an immersive sports training experience, and high-speed and low-latency 5G communication ensures real-time interaction of remote sports teaching. This makes sports teaching gradually change from static assessment to dynamic optimization, and from sloppy teaching to personalized teaching. In addition, the innovation of modern education concept forces the reform of physical education teaching mode, the traditional physical education teaching mode is oriented to the teacher's experience, and the school physical education teaching and social sports training are relatively separated. While the integration of physical education and the learner-centered education concept requires that the physical education teaching is more scientific, intelligent, personalized, and integrated, and the students' sports characteristics are accurately analyzed with the help of digital technology means, breaking the school, society, family, and dynamically adjust teaching strategies according to individual differences, so as to enhance teaching efficiency and learning effects and realize the integration and sharing of quality sports resources. Finally, the sudden global public health events in recent years have also accelerated the digital transformation of education, during the COVID-19 epidemic, the distance between people and people, people and sports competition environment increased, online teaching, blended learning has become the mainstream, physical education has also begun to explore digital means of remote guidance and data analysis. The innovation of the precise teaching

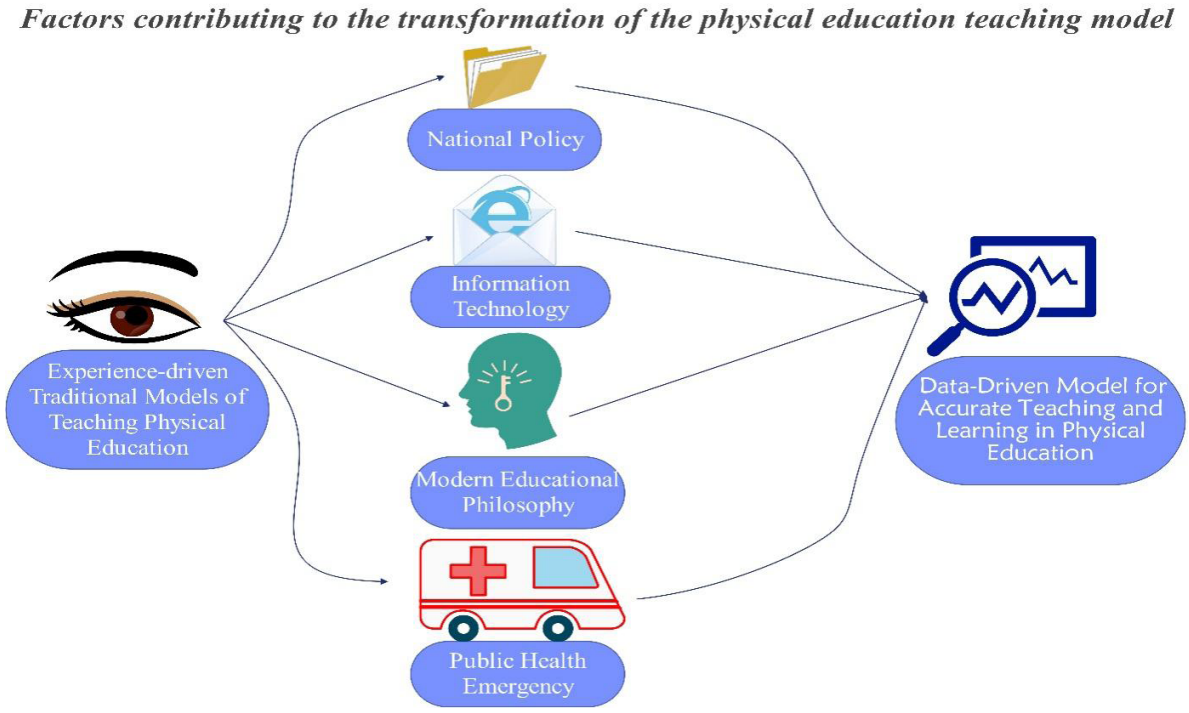

Figure 2. Factors contributing to the transformation of the physical education teaching model

mode for sports provides an unprecedented development opportunity [5].

3. The breakthrough path of data-driven sports precision teaching under the background of "Four New"

Under the "Four New" background, the data-driven sports precision teaching model aims to achieve personalized and efficient teaching through the integration of technology and education. However, the idealized blueprint of the mechanism construction encounters various phenomena of "not suited to the soil" in the process of landing, so it is necessary to put forward the corresponding optimization of the technique, model innovation, resource integration, and system guarantee—four major breakthrough paths to face the reality of bottlenecks and feed back into the optimization of the mechanism to make it more feasible and adaptable, and to promote the accurate teaching mode of physical education from theoretical ideas to real-world applications [6].

3.1. Technology optimization path

In collective projects, complex sports scenes will reduce the data signal-to-noise ratio and produce a large amount of inefficient or even invalid data, in order to solve this problem, it can be used to eliminate the blind area of the occlusion by setting up multi-camera (4–6) high-definition cameras, combined with the deep learning algorithms (e.g., YOLO, PoseNet), which is not only real-time but can also pre-determine the locating, movement, and trajectory of the athletes. Deep learning algorithms for classification, detection, tracking, and trajectory prediction are discussed and have shown great advantages in various sports. For implementation, a portable tripod or a special stand can be used to fix the camera, and edge computing and data preprocessing can be utilized to filter invalid data and extract key features to increase transmission speed to reduce latency. In addition, "digital twin" as a fusion between real and virtual products can also be used to improve the effect of data application, to make digital objects coexist with real-world objects and interact with them in real time through extended reality (XR) technology, making them "digital doppelgängers" of the

learners. For example, in table tennis training, the system collects students' serve speed and reaction time, generates virtual coaches for their weaknesses (slow receiving and serving), and repeatedly reinforces technical movements according to the dynamically adjusted practice plan [7].

3.2. Mode innovation path

Traditional physical education teaching is based on large classes, ignoring individual differences, resulting in uneven teaching results. While the sports precision teaching model is personalized by analyzing students' physiological, movement, and behavioral data, the rigidity of the model and the lack of teachers' adaptive ability limit its implementation. Based on the Newell constraint model (see **Figure 3**), motor skill development needs to balance individual constraints, task constraints, and environmental constraints. To this end, individual constraints (e.g., fitness data), task constraints (e.g., shot hit rate), and environmental constraints (e.g., field conditions) are dynamically grouped based on historical data and current sport performance using a K-means clustering algorithm, taking into account both individualized and collaborative needs. Within different groups, personalized training tasks are intelligently assigned through AI algorithms to ensure that students have the best experience within their abilities. For example, in handball training, the system analyzes the shooting hit rate, passing success rate, and physiological data to assign technical movement exercises for students with weaker skills and low-intensity ballistic exercises for those with insufficient physical strength. In addition, the development of motor skills can never be accomplished through classroom practice, but requires the concerted efforts of "family-society-school" to integrate the high-quality data collected in the classroom into a "movement-problem-solution" motor knowledge map, improve data analyzability, and help learners develop their motor skills in the classroom. The data can be analyzed to help learners practice at home and in society. For example, in handball training, the knowledge map can link "blocked shot" with "late jump and short lag time," and recommend explosive leg strength and core strength training [8].

3.3. Resource integration path

The sports precision teaching model requires high requirements for smart devices, curriculum resources, and teachers' abilities, but uneven resources and budgets between regions and schools limit the popularization. For this reason, we should lower the threshold, bridge the education divide, and improve the efficiency of resource utilization through cloud platform sharing and low-code (LCP) tool development, as well as cooperation with technology companies. Specifically, the ability of cloud computing platforms to integrate equipment,

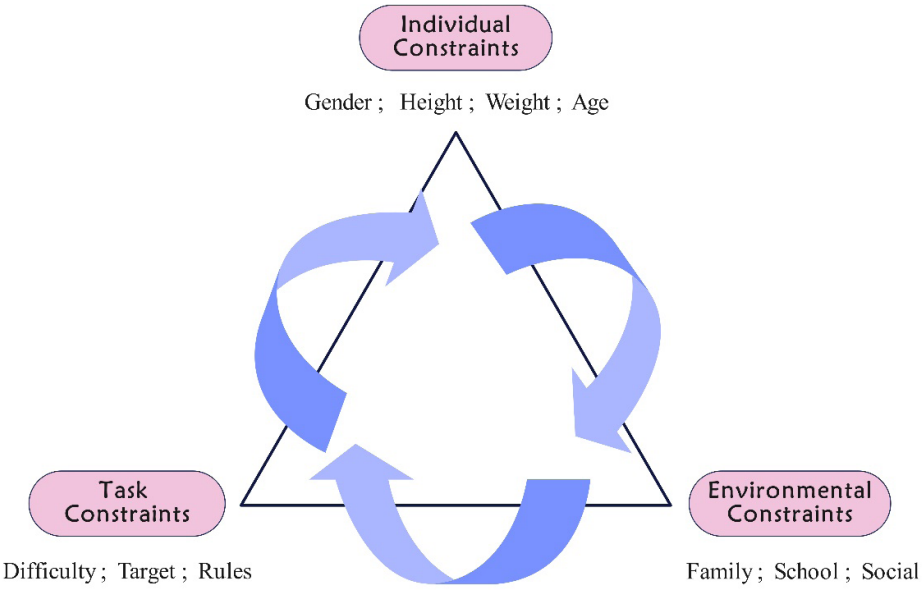

Figure 3. Newell constraints model

curriculum, and experience resources can greatly reduce the investment of separate schools in precision teaching, where schools in economically developed regions share equipment by uploading multi-camera AI vision systems and mature lesson plans to the platforms, and schools in economically less-developed regions obtain services through subscriptions. In addition, the rise of low-code platforms has made the lack of teachers' digital literacy no longer a limiting factor in the promotion of precision teaching. In handball teaching, teachers drag and drop modules to generate running trajectories and heart rate analysis panels, which allow them to formulate training plans without programming, lowering the threshold of data visualization and improving data availability [9].

4. Conclusion and prospects

As a powerful engine for national revitalization and social progress, data-driven sports precision teaching has far-reaching strategic significance and practical value as an innovative practice of the "Four New" construction in the field of physical education. Based on the background of the "Four New" construction, this paper focuses on the mechanism construction, practical bottlenecks, and breakthrough paths of physical education precision teaching, and seeks to promote the transformation of physical education teaching from the traditional experience mode to intelligent, personalized, and data-driven, so as to realize the quality revolution and high-quality development of physical education in China. The data-driven precision teaching of physical education needs to adhere to the concept of technology integration and practice orientation, adhere to serve the people's expectations for a healthy life, adhere to serve the people's aspirations for high-quality education, adhere to serve the modernization and development of national and local education, and adhere to better show the educational value and social function of physical education. Breaking through the limitations of traditional "one-size-fits-all" teaching, creatively constructing a precise teaching mechanism that includes technology integration, operation guarantee, and collaborative innovation, promoting the in-depth fusion and revolutionary innovation of "technology-teaching-capacity-system," realizing the connotative, high-quality, and innovative development of physical education, and cultivating more high-quality physical education talents who can adapt to the social needs. To better serve the national strategy of building a strong education country, a strong sports country, and a healthy China, future research can focus on cost control, teacher empowerment, and system improvement to ensure its universality in different regions and provide sustainable impetus for physical education reform [10].

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References

[1] Stanmore E, Stubbs B, Vancampfort D, et al., 2017, The Effect of Active Video Games on Cognitive Functioning in Clinical and Non-Clinical Populations: A Meta-Analysis of Randomized Controlled Trials. Neuroscience & Biobehavioral Reviews, 78: 34–43.

[2] Huang K, Zhao Y, He R, et al., 2022, Exergame-Based Exercise Training for Depressive Symptoms in Adults: A Systematic Review and Meta-Analysis. Psychology of Sport and Exercise, 63: 102266.

[3] Carney R, Firth J, 2018, mHealth and Physical Activity Interventions among People with Mental Illness, Exercise-Based Interventions for Mental Illness, Academic Press, 217–242.

[4] Monroe CM, 2016, Valuable Steps Ahead: Promoting Physical Activity with Wearables and Incentives. The Lancet Diabetes & Endocrinology, 4(12): 960–961.

[5] Wang JB, Cadmus-Bertram LA, Natarajan L, et al., 2015, Wearable Sensor/Device (Fitbit One) and SMS Text-Messaging Prompts to Increase Physical Activity in Overweight and Obese Adults: A Randomized Controlled Trial. Telemedicine and e-Health, 21(10): 782–792.

[6] Mu S, Cui M, Huang X, 2020, Multimodal Data Fusion in Learning Analytics: A Systematic Review. Sensors, 20(23): 6856.

[7] Liu S, Zhang J, Zhang Y, et al., 2020, A Wearable Motion Capture Device Able to Detect Dynamic Motion of Human Limbs. Nature communications, 11(1): 5615.

[8] Liang JM, Su WC, Chen YL, et al., 2019, Smart Interactive Education System Based on Wearable Devices. Sensors, 19(15): 3260.

[9] Richlan F, Weiß M, Kastner P, et al., 2023, Virtual Training, Real Effects: A Narrative Review on Sports Performance Enhancement Through Interventions in Virtual Reality. Frontiers in Psychology, 14: 1240790.

[10] Suo X, Tang W, Li Z, 2024, Motion Capture Technology in Sports Scenarios: A Survey. Sensors, 24(9): 2947.