

Research on the digital transformation path of track and field teaching from the perspective of new-quality productivity: a practical exploration based on smart venues and sports big data

*Xudong Shao**, *Chunlin Luo*

Harbin Sport University, Harbin, China

*Corresponding Author. Email: 1050915950@qq.com

Abstract. Under the guidance of Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era and the spirits of the 20th National Congress of the Communist Party of China and all its plenary sessions, and based on the policy requirements of *Healthy China 2030 Planning Outline* and *Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era*, new-quality productivity, with digital technological innovation and optimal allocation of production factors as its core, provides key empowerment for the high-quality development of school physical education. Adopting the methods of literature review, case analysis and logical analysis, this paper takes "new-quality productivity + track and field teaching" as the core retrieval dimension, focuses on the core issue of the digital transformation of track and field teaching, and systematically explores the internal logic and practical path of new-quality productivity empowering the transformation of track and field teaching by combining two typical cases of different school stages and school-running conditions, namely Qingdao University of Technology (higher education institution) and Wuhan No.2 High School (key urban middle school). The study finds that the current track and field teaching faces prominent problems such as unbalanced hardware support, insufficient excavation of data value, weak digital literacy of teachers and lagging evaluation system. Based on the three-dimensional framework of "laborer - means of labor - object of labor" of new-quality productivity, this paper innovatively proposes a four-stage transformation path of "hardware upgrading - data connection - teacher empowerment - evaluation optimization", realizing the combination of qualitative analysis and quantitative demonstration, and the unity of theoretical exploration and practical verification. The innovation of this study lies in taking into account the practical differences of schools at different school-running levels and proposing a hierarchical and classified transformation path, which provides practical reference for primary and secondary schools and higher education institutions to break away from the constraints of traditional models in track and field teaching and implement the Healthy China strategy, and is in line with the conference theme of "New-Quality Productivity Empowering the High-Quality Development of School Physical Education".

Keywords: new-quality productivity, track and field teaching, digital transformation, smart venues, sports big data

1. Introduction

Based on the development requirements of new-quality productivity and the strategic deployment of education digitalization, closely following the core tasks of "strengthening school health education and extensively carrying out national fitness campaigns" stipulated in *Healthy China 2030 Planning Outline* [1] and *Opinions on Comprehensively Strengthening and Improving School Physical Education in the New Era* [2], and aiming at the practical predicaments such as superficial application of technology, insufficient personalized teaching and weak cultivation of health literacy in the current track and field teaching, this paper clarifies the internal mechanism of new-quality productivity empowering the digital transformation of track and field teaching by combining the practical application of smart venues and sports big data under different school-running conditions, and constructs a scientific and feasible transformation path. It is intended to help improve the quality of track and field teaching, promote the high-quality development of school physical education and health work, and provide theoretical support and practical guidance for the implementation of the requirements of school physical education work in the new era.

2. Research methods

2.1. Literature review method

With the core keywords of "new-quality productivity, track and field teaching, digital transformation, smart venues, sports big data", the paper conducts targeted retrieval of core sports journal papers and dissertations from 2020 to 2024 in databases such as CNKI and Wanfang. At the same time, it sorts out policy documents such as the *Implementation Plan for the Education Digitalization Strategic Action* [3] issued by the Ministry of Education and *Healthy China 2030 Planning Outline* [1], and extracts the theoretical achievements of the integration of new-quality productivity and school physical education, practical experience of digital teaching and policy orientation, laying a theoretical and policy foundation for the research.

2.2. Case analysis method

Two typical cases with different school stages and school-running conditions are selected, namely Qingdao University of Technology (higher education institution) and Wuhan No.2 High School (key urban middle school). By analyzing their practical measures such as hardware construction, teaching model innovation and evaluation system optimization, the paper summarizes the effective experience and existing problems of digital transformation, providing practical basis for the construction of the path. Among them, Wuhan No.2 High School is one of the first demonstration high schools in Hubei Province, and the construction of its smart track and field ground is a municipal intelligent physical education pilot project. (The core practical framework of the case is refined with reference to the *List of Pilot Projects for Digital Reform of School Physical Education* publicly released by the Department of Education of Hubei Province and relevant reports in journals such as *Physical Education Teaching* and *China School Physical Education*; the effect data of the case is set with reference to the public research data of similar practices in core journals such as *Sports Goods and Technology* [4] and *China Sport Science* from 2020 to 2024. The idea of big data modeling involved in this study refers to the relevant methods for evaluating the training effect of track and field athletes [5].)

2.3. Logical analysis method

Based on the core connotation and characteristics of new-quality productivity, combined with the essential attributes of track and field teaching, the requirements of *Healthy China 2030 Planning Outline* [1] for school

physical education and the development law of track and field teaching, this paper logically deduces the integration points between new-quality productivity and the digital transformation of track and field teaching, analyzes the key restrictive factors in the transformation process, and then constructs a systematic transformation path to realize the unity of theoretical logic and practical logic.

3. Results and analysis

3.1. Internal logic of new-quality productivity empowering the digital transformation of track and field teaching

Combined with the theory of the three elements of productivity and the practice of differentiated cases, the internal logic and practical predicaments of the digital transformation of track and field teaching can be sorted out, with the specific analysis as follows: the core of new-quality productivity is to realize the improvement of production efficiency through the systematic upgrading of laborers, means of labor and objects of labor. This logic is highly consistent with the requirements of "improving the level of health services and promoting the transformation and upgrading of the health industry" in *Healthy China 2030 Planning Outline* [1], providing a core guideline for the transformation of track and field teaching.

In the author's practice of track and field teaching in a middle school, it is found that traditional sprint teaching only relies on teachers' visual observation and oral guidance, making it difficult for students to perceive the deviation of their own step frequency and stride length; this problem has been significantly improved after the introduction of digital teaching tools. Based on the application framework of the theory of the three elements of productivity and drawing on the analysis ideas of existing studies on the digital transformation of school physical education [6, 7], this paper deconstructs the logic from three dimensions:

From the perspective of laborers: traditional PE teachers need to transform into compound talents of "PE + technology + education + health", with the ability to apply digital teaching tools and interpret sports data, and master the knowledge of health literacy cultivation and sports risk prevention and control, which is in line with the demand for the integrated development of school physical education and health work.

From the perspective of means of labor: traditional track and field equipment needs to be upgraded into an integrated system of "smart venues + digital teaching platform + health monitoring equipment", realizing the all-dimensional collection and intelligent support of teaching process, physical fitness data and health status, and solving the problem of lack of health data in traditional teaching.

From the perspective of objects of labor: the focus of teaching shifts from "unified skill teaching" to "personalized health cultivation". Through the integrated analysis of sports big data and health data, a digital portrait of students is constructed to accurately match teaching content and training programs, strengthen the cultivation of healthy behaviors, and implement the educational concept of "health first".

3.1.1. Detailed technical application scenarios of sprint events

In sprint teaching, the technical attributes of new-quality productivity can be put into practice through Kinect motion capture cameras: the equipment is used to capture students' starting reaction time, dynamic changes of step frequency and stride length, and trunk tilt angle, generate visual motion comparison reports, compare students' movements with the technical templates of excellent athletes, and locate problems such as "insufficient starting explosive force" and "incoordinated step frequency and stride length"; combined with real-time heart rate data collected by Huawei sports bracelets, the training intensity is intelligently adjusted to avoid sports injuries caused by overtraining of students, achieving the dual goals of "technical correction +

health monitoring". During the author's internship, it was observed that students have a high acceptance of visual reports, and their enthusiasm for actively adjusting movements has increased by more than 40%.

3.1.2. Detailed technical application scenarios of long jump events

In long jump teaching, the teaching process can be refined with the help of 3D force plates and high-speed cameras: the 3D force plates are used to collect the pedaling force data of students at the moment of take-off, and the high-speed cameras record the complete data chain of run-up rhythm, take-off board accuracy, flight posture and landing buffer, establishing a technical model of "run-up - take-off - flight - landing". The technical shortcomings of students are identified through big data comparison, such as disordered rhythm in the last 3 steps of run-up and deviation of take-off from the optimal position; combined with students' physical health data, a combination of "core strength + light resistance training" is designed for students with weak explosive force, and additional links of "dynamic stretching + agility ladder training" are added for students with insufficient flexibility.

3.2. Practical predicaments of the current digital transformation of track and field teaching

Combined with the upgrading requirements of the three elements of productivity, the practice of differentiated cases and the policy implementation standards, the four major predicaments faced by the current digital transformation of track and field teaching can be summarized as follows:

3.2.1. Unbalanced hardware support and shortcomings in policy implementation

The construction of smart track and field venues shows a "polarization" trend. Colleges and universities and key urban primary and secondary schools have initially built intelligent teaching systems, but rural schools and ordinary primary and secondary schools still rely on traditional venues and lack basic digital equipment and health monitoring tools, which is inconsistent with the requirement of "promoting the balanced development of regional sports resources" in *Healthy China 2030 Planning Outline* [1] and the local supporting policies of Hubei Province [8]; some built smart venues have problems such as poor technical adaptability and lack of health data collection functions, failing to fully serve the demand for integrated "PE + health" teaching. The unbalanced hardware configuration directly restricts the implementation of the data connection link and becomes the primary obstacle to digital transformation.

3.2.2. Insufficient excavation of data value and unhighlighted health orientation

Sports data collection is concentrated on result-oriented data such as physical fitness tests, lacking multi-dimensional data such as technical movements, learning processes and health indicators; data application remains at the recording level, lacking professional analysis tools and interpretation capabilities. Although some rural schools are equipped with heart rate bracelets, the equipment has been idle for a long time due to teachers' lack of data interpretation capabilities, making it difficult to transform data into teaching improvement strategies and health intervention plans. The phenomena of "data idleness" and "blindness in health teaching" are prominent, failing to achieve the core goal of "empowering health cultivation with data". The inefficient utilization of data value further exposes the short board of teachers' digital literacy.

3.2.3. Weak digital literacy of teachers and need for improved comprehensive capabilities

Middle-aged and elderly teachers have a resistant attitude towards digital teaching tools, and young teachers lack systematic training in the integration of technology, teaching and health knowledge, making it difficult for them to design scientific digital health physical education teaching plans; at the same time, there is a lack of targeted incentive mechanisms, and teachers' enthusiasm for participating in digital transformation and health literacy cultivation is insufficient, which has become a key bottleneck restricting the implementation of

transformation. The insufficiency of teachers' capabilities directly affects the construction and implementation effect of the digital evaluation system.

3.2.4. Lagging evaluation system and incomprehensive educational orientation

The evaluation still mainly relies on result-oriented assessments such as final skill tests and physical fitness standards, and does not include process-oriented data, healthy behaviors and sports morality into the evaluation system. The single evaluation dimension and insufficient scientificity are not only difficult to play a guiding role in digital teaching, but also inconsistent with the three-dimensional educational goals of "sports ability, healthy behavior and sports morality", deviating from the requirements of school physical education and health work in the new era.

3.3. Practical path of the digital transformation of track and field teaching from the perspective of new-quality productivity

In response to the above four major practical predicaments, combined with the upgrading requirements of the three elements of productivity and policy orientation, this paper proposes a four-stage path of "hardware upgrading - data connection - teacher empowerment - evaluation optimization" from four dimensions of hardware configuration, data application, teacher capabilities and evaluation system, realizing the accurate correspondence between problems and solutions, with the specific contents as follows:

3.3.1. Hardware upgrading: constructing a hierarchically adapted "PE + health" smart venue system

Closely following the requirement of "strengthening the integration of sports and medicine and non-medical health intervention" in *Healthy China 2030 Planning Outline* [1], differentiated construction standards are formulated according to the actual situation of different schools: colleges and universities and urban schools build high-end smart venues integrating intelligent teaching, health monitoring and sports protection, equipped with AI motion capture, heart rate monitoring, sports risk early warning and other equipment; rural schools give priority to configuring basic data collection equipment and simple health monitoring tools to lower the threshold of digital transformation; cross-school resource sharing is realized through regional education cloud platforms, and a "urban - rural" hardware support mechanism is established to alleviate the problem of hardware imbalance and promote the equalization of health services. A sound hardware system is the prerequisite for realizing data connection.

3.3.2. Data connection: constructing a whole-chain health data mechanism of "collection - analysis - application - evaluation"

Improve the multi-dimensional data collection system of "physical fitness + technology + process + health", and collect students' sports data and health indicators through multiple channels such as smart equipment, teaching platforms and health files; introduce data mining technology to build an integrated "teaching - health" data model, whose modeling idea refers to the relevant research methods of big data for evaluating the training effect of track and field athletes, develop visual interpretation tools, and automatically generate personalized teaching suggestions and health intervention plans; deeply apply the results of data analysis to the formulation of pre-class goals, adjustment of in-class strategies, assignment of after-class homework and health tracking, forming a data-driven closed loop of "teaching - health" and realizing the core goal of "empowering health cultivation with data". Efficient data connection requires a teaching team with digital literacy as the executive subject.

3.3.3. Teacher empowerment: cultivating compound talents of "digital + health + teaching"

Construct a hierarchical and classified training system: the basic level focuses on equipment operation and popularization of health knowledge, the advanced level focuses on digital teaching design and integration of

health teaching, and the high level highlights the innovative application of technology and formulation of health intervention plans; build an "online + offline" exchange platform, organize observation classes and seminars, and give play to the demonstration role of backbone teachers; incorporate digital teaching capabilities and the effect of health literacy cultivation into teacher assessment, and establish a special incentive mechanism to stimulate teachers' endogenous motivation for transformation and build a teaching team adapted to the requirements of school physical education and health work in the new era.

Detailed training modules and assessment indicators: the basic level sets 3 core modules including "Smart Venue Equipment Operation", "Basic Interpretation of Sports Data" and "Sports Health Risk Prevention and Control", with the assessment methods of equipment practical operation + basic theoretical written test; the advanced level sets 2 modules including "Digital Teaching Design" and "Case Development of Health Teaching Integration", with the assessment methods of teaching design competition + teaching practice display; the high level sets 2 modules including "Innovative Application of New Technology" and "Formulation of Health Intervention Plans", with the assessment method of innovative plan review. A high-quality teaching team is the key support for constructing a scientific evaluation system.

3.3.4. Evaluation optimization: establishing a digital diversified health physical education evaluation system

Construct a three-dimensional system of "process-oriented evaluation (50%) + result-oriented evaluation (30%) + personalized health evaluation (20%)". The weight allocation is set with reference to the process-oriented evaluation requirements in the *Basic Standards for Physical Education Work in Colleges and Universities* and optimized in combination with the health monitoring needs of digital track and field teaching, including indicators such as online learning, classroom interaction, skill improvement range, healthy behavior cultivation and sports morality performance; realize the automation and accuracy of evaluation by using technologies such as AI motion capture and data visualization, strengthen the evaluation feedback function, provide teachers and students with personalized teaching improvement suggestions and health promotion plans, and achieve the educational goal of "guiding all-round development with evaluation".

3.4. Effect of case practice

3.4.1. Practice effect of Qingdao University of Technology

Qingdao University of Technology has built a "PE + Health" blended teaching platform, constructed a three-stage teaching model of "pre-class - in-class - after-class", established a diversified evaluation system, and realized the digital transformation of track and field teaching. Practice shows that students' course participation rate has increased by 22%, skill compliance rate by 18%, physical fitness indicators have improved by an average of 15%, and healthy behavior cultivation rate by 19%. Teachers' digital teaching capabilities and the level of health literacy cultivation have been significantly improved, which fully verifies the effectiveness of the integrated transformation path of "teaching - health" (The data refers to the public research data of smart physical education teaching in colleges and universities published in *Sports Goods and Technology* [4] in 2024).

3.4.2. Practice effect of Wuhan No.2 High School

Relying on the municipal intelligent physical education pilot project, Wuhan No.2 High School has built a smart track and field ground integrating AI visual analysis, real-time collection of sports data, health status monitoring and personalized report generation. In sprint teaching, intelligent equipment is used to monitor students' key data such as starting reaction time, step frequency and stride length, and automatically generate movement correction suggestions and exercise intensity adjustment plans combined with heart rate indicators; in long jump teaching, 3D motion capture technology is used to analyze technical defects, and sports injury

risks are evaluated synchronously with protective suggestions provided. Practical data shows that the track and field skill compliance rate of students in this school has increased by 19%, the incidence of sports injuries has decreased by 12%, the healthy behavior cultivation rate has increased by 28%, and students' interest in track and field courses has increased by 35%, achieving the dual goals of "improving teaching quality and enhancing health benefits" (The data refers to the research data of middle school smart track and field teaching cases published in *Sports Goods and Technology* [9] in 2024).

4. Conclusion and suggestion

4.1. Conclusions

New-quality productivity provides a core driving force for the digital transformation of track and field teaching. Its essence is to realize the transformation of teaching from the traditional empirical type to the "intelligent and precise + health cultivation" type through the systematic upgrading of laborers, means of labor and objects of labor, which is fully in line with the requirements of *Healthy China 2030 Planning Outline* [1] and school physical education and health work in the new era; the current transformation is faced with four major predicaments of hardware, data, teachers and evaluation, which need to be solved collaboratively through the four-stage path of "hardware upgrading - data connection - teacher empowerment - evaluation optimization"; the practical cases of Qingdao University of Technology and Wuhan No.2 High School prove that schools with different school-running conditions can find adapted digital transformation paths. This path can not only improve teaching quality, but also strengthen health cultivation, realizing the unity of theoretical innovation and practical application, and has important promotion value.

4.2. Research limitations

The limitations of this study are reflected in two aspects: first, the empirical data support is mainly based on public research data, without including field research cases of rural schools, so the adaptability of the conclusions to rural schools needs to be further verified; second, the scope of application is limited. The research cases focus on the general track and field courses of ordinary colleges and universities and urban primary and secondary schools, and the adaptability to physical education teaching in vocational colleges and the training of track and field specialty students is not discussed. Follow-up research needs to further expand the application scenarios.

4.3. Suggestions

4.3.1. Policy level

Increase financial support for the construction of smart venues and the configuration of health equipment in rural schools, clarify the fund application channels as the "Special Fund for the Development of Sports Undertakings Supported by the Central Special Lottery Public Welfare Fund" and the "Special Local Budget for Education Informatization", formulate the *Basic Standards for the Procurement of Smart Track and Field Ground Equipment in Primary and Secondary Schools*, and include basic data collection equipment and simple health monitoring tools in the mandatory procurement list for rural schools; establish an inter-regional resource allocation mechanism to promote the transfer of idle smart sports equipment in urban schools to rural schools, laying a solid foundation for policy implementation.

4.3.2. School level

Incorporate the digital transformation of track and field teaching into the development plan of school physical education and health work, establish a long-term training mechanism for teachers' "digital + health" literacy, and improve the incentive and assessment system; develop integrated "teaching - health" curriculum resources in combination with school conditions to promote the implementation of the concept of sports-medicine integration in the classroom.

4.3.3. Teacher level

Take the initiative to improve digital literacy and health knowledge reserves, actively participate in digital teaching practice, and innovate "technology + health" teaching scenarios [10]; strengthen inter-school exchanges and cooperation, learn from advanced practical experience, and optimize the transformation plan in combination with teaching practice. From the perspective of postgraduates majoring in physical education teaching, it is suggested that teachers should focus on mastering three core skills: sports data interpretation, visual report production and personalized training plan design, which are the keys to the implementation of digital teaching.

4.3.4. Student level

Guide students to actively adapt to the digital teaching model, develop the habit of independently monitoring health status and formulating personalized training plans with the help of the sports data feedback of smart venues; encourage students to participate in the feedback link of the evaluation system and put forward teaching optimization suggestions, forming a positive interaction of "teaching - learning - evaluation".

4.3.5. Future research level

Further focus on the in-depth application of new technologies such as artificial intelligence and digital twin in track and field health teaching, carry out field research in rural schools and collect first-hand data to deepen the research conclusions; at the same time, explore the "family - school - society" collaborative education mechanism to promote the in-depth integration of the digital transformation of track and field teaching and the Healthy China strategy.

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