

Development Directions and Implementation Pathways for High-Quality Development of Physical Education in Chinese Universities Empowered by Digital Technology

Lei Yue

Graduate University of Mongolia, Ulaanbaatar 999097, Mongolia

Abstract: Against the backdrop of the new era's educational digitalization strategy, digital technology has become the core driver empowering university physical education and advancing its connotative development. Using literature review and logical analysis, this study systematically examines the theoretical logic, operating mechanisms, and implementation pathways through which digital technology enables high-quality development in university physical education. The findings indicate that digital technology reshapes the goal system, curriculum structure, and instructional models, driving a shift from traditional physical-training orientations to competency-development orientations and establishing a modern system characterized by data-driven precision teaching and intelligent governance. The evolution toward high quality is manifested in four dimensions: an intelligent education ecosystem, personalized service provision, cross-boundary collaborative innovation, and a people-centered sustainable paradigm. Implementation pathways include strengthening top-level design to improve digital governance; innovating teaching models to build intelligent guidance and interactive practice mechanisms; enhancing faculty capacity through digital-literacy cultivation and incentive systems; and optimizing evaluation by establishing data-driven quality assurance. Empowering university physical education with digital technology is a systemic endeavor that must balance technological innovation with educational fundamentals to achieve comprehensive quality improvement, thereby providing a solid foundation for cultivating well-rounded talent and supporting the construction of an education-powerful nation.

Keywords: Digital technology, university physical education, high-quality development.

1. Introduction

General Secretary Xi Jinping emphasized: “We must plan major initiatives for further deepening reform across the board, continuously injecting strong momentum into promoting high-quality development and advancing Chinese-style modernization” [1]. Xi Jinping stresses developing new productive forces tailored to local conditions during deliberations with Jiangsu delegation China Government Network. This important statement signals that high-quality development has become the core proposition and fundamental requirement guiding all sectors in the new era. As a vital component of the national talent-training system, university sports shoulder the mission of serving the strategic goals of “Healthy China,” “Education Powerhouse,” and “Sports Powerhouse,” with development quality directly shaping educational modernization and holistic student growth. In building a Healthy China, upgrading university sports venues and facilities optimizes exercise environments, stimulates physical-activity interest, fosters healthy lifestyles, and comprehensively enhances students' fitness. In constructing an education powerhouse, sports competitions provide authentic contexts for moral education, enabling students to internalize perseverance, collaboration, and fairness, thereby advancing the fundamental task of fostering virtue through education. In building a sports powerhouse, recruiting retired athletes as coaches raises competitive levels, strengthens high-performance teams, and enhances China's international competitiveness. Nevertheless, contemporary university sports face challenges—declining student fitness, insufficient exercise habits and awareness, and underwhelming elite-team performance [2]. The traditional “sweat-based” model has reached bottlenecks in motivation,

instructional efficiency, and personalization, and no longer meets the requirements for cultivating high-caliber talent. As big data, artificial intelligence (AI), and the Internet of Things accelerate integration into education, university physical education has entered a strategic window for quality enhancement, efficiency improvement, and model innovation. Probing the intrinsic logic, development directions, and implementation pathways of digital empowerment is thus both an inevitable trajectory of reform and a timely imperative for university physical education to serve national strategies and contribute to China's modernization.

2. The Intrinsic Logic of Digital Technology Empowering High-Quality Development in University Physical Education

2.1. Connotation of Digital Empowerment for High-Quality Development

In January 2025, the National Education Work Conference called for “continuously advancing the national education digitalization strategy” [3]. The essence of digital empowerment in university physical education is a profound, system-wide restructuring—driven by big data, AI, virtual reality (VR), and IoT and oriented toward educational modernization—of goal systems, curriculum structures, instructional models, and governance mechanisms. At its core, it promotes the deep integration of PE concepts, pedagogies, and management models, thereby synergistically enhancing talent cultivation, health promotion, and cultural inheritance. From an educational perspective, digital technology advances a shift from physical-training to competency-development orientations, establishing a student-centered, outcomes-

oriented philosophy that embodies “people-centered, competence-driven, and comprehensive development.” From a sports-science perspective, it expands both the physical and value boundaries of PE: grounded in the “health first” principle, digital empowerment enables PE courses to better fulfill the fundamental mission of fostering virtue, advancing PE beyond isolated physical training toward a stage characterized by “mind–body integration and unity of knowledge and action.” Concretely, three dimensions are involved: (i) Value—strengthening the educational attributes of PE via technological enablement, elevating its roles in ideological guidance, character formation, and value cultivation; (ii) Structure—systematically optimizing curricula, content, and evaluation through informatization to raise coherence and integrity; (iii) Innovation—applying intelligent, visualized, and data-driven methods to enhance precision and interactivity and to build a smart ecosystem integrating “teaching, learning, practice, and assessment,” thereby enabling continuous improvement and dynamic optimization.

2.2. Internal Mechanism of Digital Empowerment in School Physical Education

Digital empowerment is a dynamic evolutionary process with data as the core production factor and system optimization as the key fulcrum. Its logic lies in deeply coupling information flows, data flows, and teaching flows—via IoT and AI—to shift instruction from experience-driven to data-driven paradigms and to realize continuous quality improvement and self-evolution.

As intelligent technologies advance, data has emerged as a new factor of production alongside land, labor, and technology, playing foundational and strategic roles in digital and intelligent transformation [4]. Embedding data elements provides core momentum for PE reform: with IoT sensors, wearables, and intelligent vision systems, students’ performance, physiological indicators, and skill states are continuously collected and transformed into analyzable resources. These data enable dynamic health monitoring and precise profiling, inform instructional design, curricular adjustment, and management decisions, overcome reliance on teacher experience, and lay the groundwork for precision teaching and personalized guidance.

Process restructuring is central. Large-scale online PE has transcended the time–space limits of traditional school PE, initially forming a “learn anywhere, learn for all” model and driving deep integration between internet technologies and PE environments [5]. At the implementation level, AI generates personalized plans from learning analytics, while VR creates immersive scenarios, re-positioning teachers as facilitators and data interpreters. For students, real-time feedback supports self-awareness and reflection, enabling dynamic path adjustment and a fundamental shift from standardization to personalization. During training, instant feedback and scientific monitoring improve precision, safety, and effectiveness. In evaluation, multi-source data integration underpins a comprehensive assessment framework covering skill mastery, physical development, and engagement, shifting assessment from outcome-dominant to a balance of process and development.

Innovations in resource integration and collaboration further optimize the system. Unified digital PE management platforms enable intelligent scheduling and dynamic sharing

of facilities, equipment, and faculty, breaking resource silos, improving utilization on and off campus, and linking school–family–society resources to form an open, shared ecosystem—transforming governance from fragmentation to collaborative coordination. Finally, continuous improvement mechanisms provide endogenous momentum. Through cyclical data collection, analysis, execution, and evaluation, digital systems dynamically monitor instructional quality and resource allocation, generating feedback-driven self-optimization. For example, public PE course platforms and open, efficient evaluation databases inform reform and decision-making, supporting the ongoing enhancement of course quality [6]. The system thus transitions from static operation to dynamic evolution, forming an intelligent, adaptive ecosystem and shifting from exogenous input to endogenous innovation as the primary driver of sustainable, high-quality development.

3. Development Directions for Digital Technology–Empowered High-Quality University Physical Education

Driven by educational digitalization strategies and modern university governance, university PE is moving from traditional paradigms to systemic transformation featuring intelligence, precision, and integration. Deep embedding of digital technology not only reconfigures PE’s operational logic but also catalyzes a paradigm shift from structural refinement to systemic reconstruction—primarily expressed in the deepening of an intelligent education ecosystem, the precise expansion of personalized services, the systematic extension of cross-boundary collaborative innovation, and the establishment of a people-centered sustainable paradigm.

3.1. Building a Deeply Integrated Intelligent Education Ecosystem

The rise of AI will propel school sports into a new phase [7]. Traditional PE centered on classrooms and venues with fixed temporal–spatial boundaries. Under intelligent development, PE is evolving into a multidimensional system spanning classroom teaching, extracurricular exercise, physical-fitness monitoring, competitive training, and health management. Information-technology embedding and data circulation organically connect these components, forming an “all-time, all-element, all-process” intelligent ecosystem. Within it, data serves as the key resource: students’ performance, health metrics, and learning behaviors are recorded, analyzed, and fed back in real time to inform precise decisions. PE professionals can acquire, process, store, analyze, and utilize targeted data across authentic scenarios, substantially improving quality and effectiveness [8]. Simultaneously, AI enables intelligent management and dynamic adjustment, freeing teachers from routine tasks to focus on pedagogical innovation and personalized guidance. The smart sports ecosystem thereby raises efficiency and quality while advancing the intrinsic educational mission of university PE—embodying deep integration of technology and educational philosophy.

3.2. Enhancing Personalized Service Capabilities for Precise Provision

The core of high-quality development is meeting diverse individual needs. Digital progress has made personalization

in university PE practically attainable. By integrating learning-management systems, sports-health databases, and fitness-monitoring platforms, institutions can construct digital student profiles covering physiological, psychological, athletic, and behavioral dimensions. Based on these profiles, systems dynamically generate individualized exercise prescriptions and health-guidance plans, fostering habits and developmental paths suited to each student. In this process, PE transitions from a supply-driven to a demand-responsive model: content, training plans, and assessment standards shift from uniform designs to algorithm- and analytics-supported, flexible, and differentiated configurations. Students select content and participation formats aligned with interests, abilities, and career plans, constructing personalized learning pathways. Such precision services enable PE to genuinely support each learner's growth and lifelong development—uniting physical and mental health with character development and advancing PE from solely “physical development” to integrated “moral” and “intellectual” cultivation, thereby embodying a people-centered orientation.

3.3. Advancing Open, Collaborative Cross-Boundary Integration and Innovation

Digital technology provides both technical support and institutional space for breaking systemic boundaries and achieving cross-boundary collaboration. Future university PE will feature integration of on- and off-campus resources, interdisciplinary collaboration, and virtual–physical synergy. At the resource level, open-sharing mechanisms centered on digital platforms should facilitate exchange of high-quality courses, teaching resources, and research outcomes. Universities can open cloud-based PE resources to society, attracting community instructors and retired athletes to participate in teaching and guidance, thereby fostering two-way flows and social collaboration. At the disciplinary level, digital technology accelerates integration of sports science with medicine, psychology, biomechanics, and computer science, giving rise to fields such as sports-health management and digital sports engineering. This broadens research frontiers and diversifies pathways for cultivating interdisciplinary talent. Meanwhile, virtual–physical interaction creates new instructional scenarios: VR/AR enable immersive skill learning and competition simulation, transcending time–space limits; online sports communities coupled with offline activities build novel learning collectives, extending the breadth and depth of PE. In essence, cross-disciplinary integration leverages technology to connect diverse fields and actors, achieving resource complementarity and value co-creation and steering university PE toward systemic openness and collaborative innovation.

3.4. Building a People-Centered Sustainable Development Paradigm

The ultimate goal of digital technology is to promote the comprehensive development of the individual. The high-quality development of university physical education must therefore be people-centered, placing educational ethics and humanistic care on par with technological innovation. The essence of technological empowerment is not to replace teachers with machines, but to enhance educators' professional judgment and instructional capacity through intelligent tools; not to define students by data, but to leverage data to more fully understand their learning needs and developmental potential. Minister Huai Jinpeng stressed the

need to “strengthen norms concerning AI ethics and privacy protection within digital education to properly guide and build platforms [9].” Looking ahead, university sports should establish a technology-application standards system premised on educational ethics, reinforce data security and privacy protection, and prevent misuse of technology from adversely affecting the educational ecosystem. At the same time, the distinctive role of sport in value formation and cultural inheritance should be fully harnessed. Digital means can be used to cultivate a positive, healthy campus sports culture while fostering students' digital literacy, teamwork, and lifelong exercise awareness. Digital technology thus serves not only as a teaching tool, but also as a medium for cultural generation and character formation. Sustainability is also reflected in a system's capacity for self-optimization. By establishing data-feedback and continuous-improvement mechanisms, university sports can form a closed loop of dynamic monitoring, real-time evaluation, and self-regulation, thereby realizing a virtuous cycle linking resource allocation, instructional quality enhancement, and improved educational outcomes. At its core, this paradigm seeks a unity of technological advancement and humanistic values, ensuring that high-quality development in university sports remains technologically leading and retains the human warmth intrinsic to education—thus supporting long-term sustainability and intergenerational continuity.

4. Implementation Pathways for Digital Technology to Empower High-Quality Development in University Physical Education

4.1. Strengthening Top-Level Design to Build a Digital Strategy Leadership System

Successful digital transformation in university physical education first depends on systematic top-level design. In response to the national digital-education strategy, universities should integrate PE digitalization into overall institutional development plans, forming a complete governance loop of planning, standard setting, implementation oversight, and effectiveness evaluation. Core tasks include clarifying strategic goals, designing feasible implementation pathways, and establishing supporting policy frameworks. Specifically, universities should formulate PE-specific digital development plans with clear objectives, phased tasks, and key performance indicators; establish cross-departmental coordination to align teaching, IT construction, and research innovation; refine standards covering data collection, platform interfaces, and security management; and build a governance structure featuring university-level coordination and department-level implementation to ensure sustained resources, policy support, and funding. In addition, institutions should actively connect with national platforms (e.g., the National Education Digitalization Strategy Platform) and “smart sports” demonstration bases to form a multi-tier governance arrangement—national guidance, regional collaboration, and institutional implementation—thus fostering productive interaction between top-level design and grassroots innovation and safeguarding systematic, sustainable transformation.

4.2. Innovating Teaching Models to Advance Intelligent Transformation in Physical Education

Systemic pedagogical innovation is central to digital empowerment. Universities should leverage intelligent technologies to develop models that integrate smart guided learning, interactive practice, and dynamic feedback. Smart guidance employs AI to analyze performance data in real time, precisely identifying individual differences and technical weaknesses, supporting teachers' decisions and generating personalized learning plans for accurate anticipation and scientifically grounded guidance. Interactive practice draws on VR and motion-capture to create immersive learning environments in which students acquire and train skills within blended virtual–physical contexts; real-time recording and visualization of learning behaviors significantly improve interaction quality and learning experience. Dynamic feedback uses learning analytics and intelligent assessment to deliver multidimensional evaluation and instant feedback, enabling teachers to adjust strategies in real time and establishing a virtuous cycle integrating teaching, learning, and assessment. This technology-enabled model not only raises efficiency and engagement, but also provides a robust data and algorithmic foundation for continuous quality improvement.

4.3. Enhancing Faculty Capabilities and Refining Digital Teaching Support Systems

Faculty digital literacy and instructional innovation are decisive for transformation success. Addressing prevalent gaps—outdated conceptions and insufficient technical skills—requires a systematic development framework. First, implement end-to-end development mechanisms spanning pre-service and in-service stages, placing digital teaching competence at the core of professional growth. Through targeted trainings, workshops, and online courses, focus on data analysis, intelligent-system utilization, and digital-resource development. Second, build interdisciplinary innovation communities by integrating IT units, PE schools, and research institutes to form tech-pedagogy teams that co-develop case studies and practice projects, yielding scalable models of PE innovation. Complement these with incentives and evaluation—teaching-performance reviews, achievement recognition, and project funding—to encourage participation in digital practice and research, providing solid institutional guarantees and developmental space.

4.4. Optimizing Evaluation Mechanisms to Establish a Data-Driven Quality Assurance System

A sound evaluation mechanism underpins high-quality development. Deep application of digital technology enables a comprehensive, multidimensional, and intelligent assurance system. Universities should establish process-based, analytics-driven evaluation that integrates multi-source data—performance, learning behaviors, and psychological indicators—for dynamic monitoring and precise diagnosis. A multi-stakeholder framework combining faculty appraisal, student self-evaluation, and system evaluation enhances objectivity and the specificity of feedback, making improvement routine. More importantly, build a data-driven continuous-improvement mechanism linking evaluation outputs with instructional design, course management, and

resource allocation to create a decision-optimization loop. Thus, evaluation shifts from mere outcome measurement to the core driver of sustained quality enhancement, emphasizing data insights to propel systemic self-improvement and continuous development.

5. Conclusion

Empowering university physical education through digital technology is an inevitable requirement of the deep integration between education digitalization and the national strategy to build a sports powerhouse. It is also a systematic endeavor to move from traditional models toward intelligent, personalized, and sustainable paradigms. By elucidating the intrinsic logic, mechanisms, and developmental trajectories of digital empowerment and proposing actionable pathways, this study shows that empowerment is not merely a tool-level upgrade but an all-round reshaping of educational philosophy, pedagogy, and governance. Crucially, technological empowerment is incremental and iterative. Future high-quality development must balance innovation with the essence of education: advance intelligence while upholding the mission of cultivating people; use data while maintaining humanistic care; and pursue efficiency while safeguarding equity. Only in this way can digital technology truly drive connotative development in university PE and foster well-rounded new-era talent in morality, intellect, physique, aesthetics, and labor—providing solid support for building an education-powerful nation and a Healthy China.

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