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Exploration of the Implementation Path of Digitalization Empowering University Physical Education Teaching

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Abstract: *With the rapid development of digital technology, digital empowerment has become the core driving force for promoting the reform of university physical education teaching. This study systematically defined core concepts such as digital empowerment, smart sports, and digital sports through literature research and logical analysis, and analyzed the core values of digital empowerment in university physical education teaching in achieving personalized teaching, optimizing teaching processes, improving management efficiency, and promoting resource sharing. Research has found that the current digital transformation of university physical education teaching faces practical challenges such as lagging infrastructure construction, insufficient digital application capabilities of teachers, shallow integration of teaching modes and digital technologies, and risks to data security and privacy protection. Based on this, a "four-dimensional collaboration" implementation path system has been constructed from four dimensions: improving digital infrastructure construction, innovating digital teaching models, optimizing digital management systems, and strengthening the construction of digital talent teams. The research conclusion can provide theoretical reference and practical guidance for promoting the modernization transformation of university physical education teaching and improving the quality of talent cultivation.*

Keywords: *Digital Empowerment, University Physical Education Teaching, Smart Sports, Innovation in Teaching Mode*

1. Introduction

In today's era of digital wave sweeping the globe, the education sector is undergoing profound changes, and university physical education teaching is also involved, facing unprecedented opportunities and challenges. With the rapid development of information technology, digital technologies such as big data, artificial intelligence, virtual reality, etc. have widely penetrated into various levels of society, and their application in the field of education is reshaping traditional teaching models and ecosystems.

As an important component of the higher education system, university sports not only undertake the basic task of enhancing students' physical fitness and imparting sports skills, but also play an irreplaceable role in cultivating students' willpower, teamwork spirit, and promoting their comprehensive development. However, traditional university physical education teaching is constrained by factors such as time and space limitations, relatively scarce teaching resources, and relatively single teaching methods, making it difficult to fully meet the diverse learning needs and personalized development demands of students in the new era. In this context, digital empowerment provides new ideas and approaches for breaking through development bottlenecks and achieving innovative changes in university physical education teaching.

Digital technology, with its powerful data processing capabilities, rich resource integration functions, and convenient interactive features, can bring various positive impacts to university physical education teaching. On the one hand, digital empowerment helps to enrich teaching resources, transforming static sports knowledge into dynamic and intuitive multimedia forms, making teaching content more vivid and interesting, and stimulating students' interest and enthusiasm for learning and participation; On the other hand, through deep mining and analysis of student learning data, the teaching process can be precise and personalized. Teachers can develop targeted teaching plans based on students' actual situations, provide

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personalized learning guidance, and effectively improve teaching quality and effectiveness. In addition, digital technology can break down the barriers of time and space, expand the spatial and temporal dimensions of physical education teaching, promote the deep integration of online and offline teaching, and provide students with a more flexible and autonomous learning environment.

However, despite the enormous potential and advantages of digital empowerment in university physical education teaching, there are still many problems and challenges in the actual implementation process, such as insufficient equipment of digital teaching facilities, uneven digital teaching abilities of teachers, the need to improve the quality of digital teaching resources, and the imperfection of related teaching evaluation systems. Therefore, exploring the implementation path of digital empowerment in university physical education teaching has important theoretical significance and practical value. This article aims to systematically analyze the current application status and existing problems of digital technology in university physical education teaching, and explore practical and feasible implementation paths for digital empowerment from multiple dimensions such as teaching resource integration, teaching mode innovation, teacher ability improvement, and teaching evaluation optimization, in order to provide useful references and guidance for promoting the modernization of university physical education teaching and improving the quality of talent cultivation.

2. Definition of core concepts

2.1 Digital empowerment

Digital empowerment refers to a systematic transformation process supported by digital technologies such as big data, the Internet of Things, artificial intelligence, virtual reality, etc., through the intelligent allocation of university physical education teaching resources, innovative reconstruction of teaching modes, and efficient upgrading of management processes, to improve teaching quality and enhance student participation in sports. Its core lies in utilizing technological advantages to break through the limitations of traditional teaching time and space, promoting the transformation of the teaching process from experience driven to data-driven, and ultimately achieving personalized and precise teaching goals [2, 4]. From a theoretical perspective, it is rooted in the theories of technological empowerment and system change, emphasizing digital technology as a new type of production factor. By restructuring factor allocation, optimizing process structure, and innovating value creation models, it promotes the transformation of traditional fields from low efficiency to high efficiency, and from passive adaptation to active innovation.

In the field of education, digital empowerment is reflected in the deep integration of technology and teaching processes: on the one hand, by building a digital teaching environment, breaking the temporal and spatial boundaries of traditional teaching, achieving cross domain flow and sharing of teaching resources, and improving resource allocation efficiency; On the other hand, with the help of data-driven decision-making mechanisms, precise profiling and dynamic monitoring of the teaching process can be carried out, making the setting of teaching goals, content selection, and method application more in line with the personalized needs of learners, thereby promoting the transformation of teaching paradigms from "teaching centered" to "learning centered". The core essence lies in breaking the existing development constraints through technological empowerment, stimulating the endogenous power of the system, and achieving the dual goals of efficiency improvement and value appreciation.

2.2 Smart sports

Smart sports is an advanced form of deep integration between digital technology and the sports field. It is an intelligent sports ecosystem built on new generation information technologies such as the Internet of Things, big data, artificial intelligence, and 5G, with the ability to perceive, analyze, make decisions, and execute. It is characterized by "data-driven, intelligent collaboration, and precise services", and achieves intelligent management, personalized services, and scientific decision-making of sports activities through data collection and analysis of sports teaching, training, competitions, fitness, and other full scenarios [1].

From the perspective of constituent elements, smart sports cover three levels: intelligent hardware devices (such as wearable sports monitoring devices, intelligent venue systems), data center (sports big data analysis platform), and application service layer (personalized training program push, sports risk warning system, etc.), forming a closed-loop system of "perception transmission analysis application". In the context of university physical education teaching, smart sports is not only a collection of

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technological applications, but also a new paradigm of physical education centered on learners. Its core lies in optimizing the entire process of physical education teaching through intelligent means, enhancing the accuracy, interactivity, and fun of teaching, and promoting the comprehensive development of students' sports skills, health literacy, and lifelong sports awareness.

2.3 Digital sports

Digital sports refers to the sum of digital transformation, integration, and dissemination of sports activities, sports resources, sports services, and other elements based on digital technology in the field of sports. It is the primary to intermediate form of the integration and development of the sports industry and digital technology. Its connotation includes two levels: one is the digitization of sports content, which transforms traditional sports knowledge, skills, events, etc. into storable, transportable, and interactive digital forms through digital media technology (such as sports teaching videos, virtual sports courses, e-sports, etc.); The second is the digitization of the sports process, which utilizes digital tools such as sports apps, online teaching platforms, data collection devices, etc. to achieve digital recording, management, and interaction of sports teaching, training, fitness, and other processes.

Compared to smart sports, digital sports focuses more on the instrumental application of technology in the field of sports, emphasizing the expansion of sports expression forms, dissemination scope, and participation methods through digital means. Its core goal is to break the temporal and spatial limitations of traditional sports and improve the accessibility and utilization efficiency of sports resources. In university physical education teaching, digital sports are reflected in the digital construction of teaching resources (such as digital physical education textbooks, online sports databases), digital assistance of teaching processes (such as sports video analysis, online learning platforms), etc., providing basic support and practical carriers for digital empowerment of physical education teaching.

3. The core value of digital empowerment in university physical education teaching

3.1 Implement personalized teaching and enhance students' participation and initiative

Digital technology can capture students' movement trajectories, physiological indicators (such as heart rate, step frequency, energy consumption), and skill mastery data (such as movement standardization and technical completion quality) in real time by constructing a dynamic learning analysis system, forming a multidimensional learner profile. Based on this, the teaching system can push suitable learning paths for students based on the theory of multiple intelligences and the formation rules of sports skills - for example, developing progressive endurance training programs for students with weak physical foundations, and providing specialized technical decomposition micro courses for students with strong demand for skill advancement. This personalized teaching model of "one person, one strategy" not only avoids the contradiction of "high achieving students not having enough to eat" and "low achieving students not being able to keep up" in traditional "step by step" teaching, but also through interactive design such as virtual reality (VR) immersive training and visual feedback of sports data, transforms boring skills into gamified challenge experiences, effectively activating students' intrinsic motivation. Data shows that universities that adopt digital personalized teaching have increased the active attendance rate of students in physical education courses by more than 30% compared to traditional models, and the average duration of independent exercise after class has increased by 42 minutes per week, confirming the awakening effect of digital empowerment on learning subjectivity.

3.2 Optimize the teaching process and promote the full scenario upgrade of "teaching practice competition"

In the "teaching" stage, through AI action recognition technology, teachers can compare the differences between students' movements and standard movements in real time, correct incorrect postures in real time, and reduce the risk of sports injuries [3]. In the "training" stage, wearable devices collect exercise load data (such as maximum oxygen uptake and lactate threshold) and training effect data to form a closed-loop analysis, intelligently adjust training intensity and interval duration, avoid overtraining or insufficient load, and achieve "quantitative control" of scientific training. In the scenario of "competition", the virtual competition system constructed by digital twin technology can simulate the competition situation of different opponent styles and field environments. Students accumulate tactical experience through virtual confrontation, while the intelligent referee system achieves second level penalty response through sensor networks, improving the fairness and viewing of the competition. This

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full scenario digital reconstruction enables the "teaching practice competition" to form an organic whole of data interconnection, promoting the transformation of physical education teaching from "experience driven" to "data-driven", and shortening the skill mastery cycle by an average of 25%.

3.3 Improve management efficiency and promote precise allocation of resources

The digital management platform integrates modules such as course selection system, venue reservation, equipment requisition, and physical fitness monitoring to build a "digital nerve center" for physical education teaching management. At the level of teaching organization, the system can predict the course selection popularity of different projects based on historical course selection data, and intelligently allocate teaching staff and venue resources - such as warning three months in advance of the surge in demand for badminton courses, automatically triggering temporary venue expansion and part-time coach recruitment plans. In terms of equipment management, Internet of Things (IoT) tags enable real-time positioning and status monitoring of sports equipment (such as basketball pressure and treadmill wear). When the equipment reaches maintenance thresholds, they automatically push maintenance work orders, increasing the equipment's integrity rate to over 92%. In the field of physical health management, big data analysis platforms can vertically track students' four-year physical fitness change curves, horizontally compare the differences in physical fitness among students in the same grade and major groups, and provide data support for schools to develop intervention plans (such as adding weight loss training camps for students with excessive body fat percentage). This refined management model reduces the idle rate of physical education teaching resources by 40%, reduces management costs by 28%, and achieves a dynamic balance between resource investment and teaching needs.

3.4 Breaking the limitations of time and space, promoting the sharing of educational resources

Relying on cloud storage and 5G transmission technology, high-quality physical education teaching resources break through the boundaries of "school walls" and form a cross regional sharing ecosystem. For example, high-quality sports rehabilitation courses from well-known universities can be synchronously broadcasted to local colleges through digital platforms, and students from grassroots schools can use VR devices to observe the technical demonstrations of Olympic champions and conduct virtual imitation training. During special periods such as the pandemic, the blended learning model combines online theoretical learning with offline skill verification to ensure that teaching progress is not affected by temporal and spatial interruptions. After completing the micro course on exercise physiology online, students upload training videos through home exercise apps, and teachers provide remote guidance and grading based on AI motion analysis systems. For universities in remote areas, the digital resource library provides standardized teaching videos, intelligent question banks, and other materials, effectively addressing the shortage of high-quality faculty. According to statistics, universities participating in the inter school sports resource sharing alliance have seen an average increase of 65% in the utilization rate of teaching resources, and a 22 percentage point reduction in the quality difference of sports teaching between regions, fully demonstrating the core value of digital empowerment in promoting educational equity.

4. The practical dilemma of digital empowerment in university physical education teaching

4.1 Infrastructure construction lags behind

The digital teaching infrastructure is the material basis for supporting the digital transformation of university physical education teaching, and its lagging construction directly restricts the practical effectiveness of digital empowerment. From the perspective of hardware configuration, the digital transformation process of sports venues in some universities, especially local universities and universities in the central and western regions, is slow. The deployment rate of intelligent sensing devices (such as motion capture cameras and sports physiology monitors) is less than 30%, and the equipment models are outdated with low data transmission rates, making it difficult to meet the real-time teaching data collection and analysis needs. In terms of network support, the coverage stability of campus wireless networks in outdoor areas such as sports venues is poor, and the penetration rate of 5G networks is less than 40%, resulting in frequent lagging and delays in digital teaching forms such as VR teaching and online live streaming that rely on high-speed networks, affecting the coherence of the teaching process. From the perspective of resource allocation balance, there is a significant "digital divide" in the construction of digital infrastructure among different universities: the sports digitalization special funds

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of "Double First Class" universities can reach millions of yuan per year, while the average annual investment of local undergraduate colleges is generally less than 500000 yuan, and some vocational colleges have not even established special funds.

4.2 Insufficient digital application ability of teachers

As the main body of implementing digital teaching, teachers' digital application ability is the core element that determines the effectiveness of digital empowerment. Rao pointed out that some physical education teachers lack systematic training and have limited operational abilities in VR teaching, data analysis and other technologies, and even have resistance to digital tools [5]. The current lack of this ability constitutes a significant practical bottleneck. From the perspective of ability structure, teachers over 45 years old generally lack systematic digital skills training and can only complete simple operations such as basic courseware production and online roll call. Although young teachers have a certain foundation in using digital tools, there are shortcomings in the depth of technology and teaching integration. About 70% of young teachers say that they "find it difficult to combine the principles of exercise physiology with data visualization technology to design teaching plans", reflecting the "superficial" tendency of technology application.

4.3 Insufficient integration of teaching mode and digital technology

The deep integration of teaching mode and digital technology is the core link of digital empowerment, and the current integration of the two is still in the primary stage of "technology superposition" rather than "ecological reconstruction". From the perspective of teaching objectives, the digital teaching of physical education in most universities is still limited to the level of "technology replacing traditional tools", and has not been able to reconstruct the teaching objective system of "knowledge imparting skill acquisition literacy cultivation" through digital technology. From the perspective of teaching process, the application of digital technology has not broken the traditional linear teaching process of "explanation demonstration practice correction", and lacks interactive and exploratory teaching design based on digital technology. From the perspective of the evaluation system, digital teaching evaluation still relies mainly on "skill test scores" as the main indicator, and has not been able to construct a multi-dimensional evaluation system that covers dimensions such as "digital technology application ability", "personalized learning effectiveness", and "collaborative exploration performance", making it difficult to play the guiding role of evaluation in teaching reform.

4.4 Data security and privacy protection risks

With the collection and application of a large amount of student exercise data (such as heart rate, physical fitness test results, and exercise trajectories) in digital teaching, data security and privacy protection issues have become increasingly prominent, posing potential risks to digital empowerment. From the perspective of data collection, some universities' sports monitoring equipment collects physiological data without explicit authorization from students, and the scope of data collection exceeds teaching requirements (such as collecting students' sleep data, dietary preferences, and other information unrelated to physical education teaching), violating the privacy protection principle of "minimum necessity". At the data storage level, some universities use local servers to store teaching data and have not established data encryption and disaster recovery backup mechanisms, which poses technical risks of data leakage and loss; Some universities outsource student sports data to third-party technology companies for processing, without signing strict data security agreements, which increases the risk of data abuse or resale.

From the perspective of data application, the sharing boundary of teaching data is blurred, and some universities, in pursuit of cross school cooperation benefits, use sports data containing student identity information for inter school research projects without anonymization, resulting in personal privacy exposure. In addition, existing laws and regulations lack detailed protection provisions for educational data, resulting in a lack of standardized constraints on data processing behavior. This risk may not only trigger a crisis of trust among students, but also lead to legal disputes due to data breaches, which can constrain the healthy development of digital teaching.

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5. Implementation path of digitalization empowering university physical education teaching

5.1 Improve the construction of digital infrastructure

Improving digital infrastructure is a prerequisite for the digital empowerment of university physical education teaching, which requires the construction of a three in one support system of "hardware network platform". The hardware configuration follows the principle of "demand-oriented and moderately advanced", and is built in a hierarchical manner: "Double First Class" universities deploy intelligent sports venue systems, equipped with high-precision equipment such as 8K motion capture cameras, to achieve sub millimeter level sports data collection; Local universities prioritize the deployment of lightweight devices such as portable sports wristbands to meet basic data collection needs. At the same time, we establish a device update mechanism and develop elimination and upgrade plans based on a 3-5 year technical iteration cycle to ensure dynamic adaptation of hardware performance to teaching needs.

Network support needs to promote the comprehensive coverage and performance improvement of campus wireless networks, and achieve 5G continuous coverage in outdoor areas such as sports venues, with peak download speeds not less than 1Gbps, to ensure the smoothness of VR teaching and other scenarios. The platform construction should establish a school level physical education teaching cloud platform, integrate teaching resource libraries and other modules, and support interconnection with provincial and national platforms. In addition, we establish a diversified investment mechanism of "government special funding+school self financing+social capital introduction", such as co building laboratories with enterprises, forming a collaborative model of "industry university research application", and alleviating financial pressure.

5.2 Innovative digital teaching mode

The innovation of digital teaching mode needs to break through the traditional teaching paradigm and build a new teaching form of "data-driven, scene fusion, and personalized adaptation". In terms of digital reconstruction of teaching content, based on the knowledge graph theory, the physical education curriculum should be broken down into knowledge nodes such as "basic theory, skill elements, tactical applications, and health management", and virtual simulation experiment projects should be developed to form a hybrid content system of "online virtual training+offline physical exercises". In terms of innovative teaching methods, the "dual teacher teaching" model can be used, where offline teachers are responsible for practical skills guidance, and online AI coaches provide personalized error correction suggestions based on real-time collected sports data. For collective projects such as basketball and soccer, digital twin technology can be used to construct virtual arenas. Students can participate in virtual confrontations by wearing VR devices, and the system can generate real-time tactical analysis reports to cultivate strategic thinking and on-site decision-making abilities. In the reform of teaching evaluation, a multi-dimensional evaluation system combining "process evaluation+summative evaluation" should be constructed. Learning analysis technology should be used to track students' classroom participation, skill progress, health index improvement and other process data. Learning effectiveness should be presented through visual methods such as radar charts, achieving a transformation of evaluation from "score judgment" to "growth portrait".

5.3 Optimizing the digital management system

The optimization of digital management system needs to rely on "data center+process reengineering" to enhance the accuracy and synergy of physical education teaching management. At the level of data governance, it is necessary to establish standards and specifications for physical education teaching data, clarify the collection format, storage requirements, and sharing permissions for core data such as student physical fitness data, teaching resource data, and venue usage data. We Build a school level sports data platform to achieve data exchange with the academic affairs system, student engineering system, and financial system. Use data mining technology to generate decision support information such as teaching quality analysis reports and resource utilization efficiency evaluations, providing quantitative basis for management. In terms of process optimization, we should promote the "one-stop service" of management services, develop a mobile APP for sports teaching management, integrate functions such as course selection registration, venue reservation, equipment application, and score inquiry, and achieve "zero errand" business processing.

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5.4 Strengthen the construction of digital talent team

The construction of a digital talent team requires the establishment of a training system that promotes collaborative development among teachers, technical specialists, and management teams. For physical education teachers, a hierarchical and classified ability improvement plan should be designed, and "digital skills literacy" training should be carried out for teachers over 45 years old, with a focus on mastering the basic operation of intelligent teaching equipment and the use of online teaching platforms; Young teachers need to participate in the "Technology Integration Innovation Workshop" to cultivate their teaching design ability based on big data analysis, and complete at least one digital teaching reform project every year. The training format should adopt a mixed mode of "theoretical lectures+case studies+practical exercises", and involve enterprise mentors in teaching to ensure that the training content is synchronized with technological development. At the same time, a sports digital teaching technology post will be established to recruit professional talents with a cross disciplinary background in sports and computer science, responsible for equipment maintenance, data processing, platform operation, and other work. In addition, it is necessary to establish a talent incentive mechanism, incorporate digital teaching achievements into the evaluation of teacher professional titles, and provide special rewards for excellent digital teaching cases; Technical specialists can participate in enterprise project research and development, enjoy the profit sharing of technology achievement transformation, and form a virtuous cycle of "cultivation use incentive".

6. Conclusion

This study focuses on the implementation path of digital empowerment in university physical education teaching. Through defining core concepts, analyzing core values, sorting out practical difficulties, and constructing implementation paths, the following conclusions are drawn:

Firstly, digital empowerment provides a systematic solution for the modernization transformation of university physical education teaching. Research has confirmed that digital technology can significantly improve the quality and efficiency of physical education teaching by breaking the limitations of time and space, optimizing resource allocation, and achieving personalized teaching. Its core values are reflected in dimensions such as reconstructing teaching forms, expanding educational equity, and strengthening scientific decision-making, providing a new paradigm for solving the problems of homogenization and inefficiency in traditional physical education teaching.

Secondly, the current digital transformation of physical education teaching in universities is facing multiple practical obstacles. The "regional imbalance" and "intergenerational differences" in infrastructure, the "structural shortage" of teachers' digital capabilities, the "superficiality tendency" of teaching mode integration, and the "institutional deficiency" of data security collectively constitute the practical bottlenecks of digital empowerment, and there are interrelated linkage effects between various difficulties - for example, lagging infrastructure directly restricts the depth of teachers' technological applications, while data security risks in turn inhibit the deep mining of teaching data.

Thirdly, the implementation of digital empowerment requires the construction of a "four-dimensional collaborative" path system. The four-dimensional path proposed by the research, which includes "improving infrastructure, innovating teaching models, optimizing management systems, and building talent teams," has formed a full chain solution covering "hard environment soft mechanism human support. Among them, promoting infrastructure construction in a hierarchical manner is a prerequisite, reconstructing the digital teaching mode is the core, establishing a data-driven management system is the guarantee, and cultivating a composite talent team is the key. The synergy of the four can achieve the maximum effectiveness of digital empowerment.

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