

Research on the Digital Transformation Path of College Physical Education Teaching from the Perspective of TOE Theory

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Abstract: Using methods of literature review and logical analysis, this paper explores the theoretical foundations, value implications, practical challenges, and advancement pathways of the digital transformation of physical education in higher education institutions. The analysis reveals that the value implications manifest in three primary aspects: the elevation of teaching quality through the deep integration of digital media; the enhancement of subject quality as digital technology continuously evolves; and the optimization of the teaching environment rejuvenated by the digital economy. Utilizing the Technology-Organization-Environment framework, the research identifies several critical challenges: a digital divide in physical education caused by an imbalance in intelligent infrastructure configuration; a lack of digital literacy among teaching subjects exacerbated by rapid technological iteration; and a lagging digital environment resulting from the weak penetration of digital concepts. To address these challenges, the study proposes targeted strategies: increasing technological investment to bridge the intelligent gap; reinforcing organizational management to improve digital literacy; and optimizing the digital environment to promote the deeper adoption of digital philosophies.

Keywords: College Physical Education Teaching; Digital Transformation; TOE Theory

1. Introduction

Since the report of the 20th National Congress of the Communist Party of China proposed to "promote the digitization of education and build a learning society and a learning country with lifelong learning for all," the concept of "digitization leading education reform" has gradually become a new trend in the high-quality development of higher education. In 2023, the work points put forward by the Higher Education Department of the Ministry of Education included "accelerating the digital transformation of higher education and creating a new form of higher education and teaching" as a line of higher education reform. Thus, educational digitization has risen to the level of national strategy, and digital transformation has received extensive attention from universities. In recent years, relying on online education platforms, colleges and universities have actively explored the continuous transformation of the "offline + online" teaching model and achieved certain results. The 2024 government work report further pointed out the need to promote the innovative development of the digital economy, with the development of "artificial intelligence +" as a practical dimension, indicating the direction for the digital transformation of education. Therefore, college physical education should seize the development opportunities of digital sports, rely on digital transformation to drive the reform teaching modes, and inject value and functionality into the high-quality development and innovation of college physical education. Currently, academic achievements regarding the digital transformation of physical education are limited, focusing mainly on multi-level teaching^[1] and file management^[2]. As a new model under the background of digital sports and educational reform, it has not yet been studied. The TOE theory, as a theoretical model for analyzing the application of emerging technologies, has been widely used in fields such as the digital transformation of the sports service industry^[3] and national fitness^[4]. In view of this, based on the TOE theory, this study examines, analyzes, and reflects the theoretical logic, value implications, practical dilemmas, and promotion paths of the digital transformation of college physical education from the three levels of technology-organization-environment, aiming to realize this transformation and truly promote the high-quality development of college physical education.

2. Digital Transformation of Physical Education in Higher Education from the TOE Theory Perspective

The digital transformation of education is recognized as a process involving the coupling of technology, organization, and environment. Therefore, the impact of digitalization on physical education in higher education is also a complex process in which factors at the three levels—technology, organization, and environment—interact and influence each other.

First, at the technological level, digital technology serves as the foundation for the digital transformation of physical education in higher education. The integration of digitalization and physical education is a fundamental characteristic that distinguishes it from traditional physical education. For instance, the application of digital sports facilities and digital teaching platforms in physical education processes is key to improving the quality of physical education. Thus, the strength of digital technology directly determines the extent to which the digital transformation of physical education in higher education can be realized.

Second, at the organizational level, higher education institutions, physical education teachers, and students, as the main actors in the digital transformation of physical education, directly influence the pace and direction of this transformation. Meanwhile, the effectiveness of digital technology in physical education depends on the synergistic effect of the depth of digital support from institutions, the digital capabilities of physical education teachers, and the digital literacy of students.

Finally, at the environmental level, the teaching environment serves as a safeguard for the digital transformation of physical education in higher education. This includes the digital institutional environment, physical education teaching models, and the overall sports culture atmosphere. Countries are actively formulating policy documents to guide the development of AI in education, taking into account the broader external social environment, keeping pace with trends of the times, and ensuring effective teaching and research in artificial intelligence.

3. The Value Implication of Digital Transformation in Physical Education of Colleges and Universities

3.1 Deep Integration of Digital Media to Enhance the Quality of Physical Education Teaching

The digital transformation significantly improves the efficiency of physical education instruction. By integrating technologies such as Augmented Reality (AR) and Virtual Reality (VR), universities can create smart sports venues and virtual simulation environments. These "immersive" teaching experiences allow students to learn and master technical movements from three-dimensional perspectives. From golf swings to curling techniques on a virtual ice rink, students can practice skills within simulated environments, which stimulates learning interest and enhances teaching efficiency beyond the constraints of time and space.

Furthermore, digital transformation strengthens the monitoring and feedback mechanisms in physical education. Through digital technology, instructors can vividly illustrate human physiological structures and project dynamics. More importantly, they can conduct biomechanical analyses of students' movements. Real-time monitoring and data feedback enable a precise understanding of each student's progress, thereby facilitating optimized instructional design.

3.2 Enhancing the Digital Literacy of Key Stakeholders to Drive Teaching Quality

As the main participants in the physical education field, the digital literacy of both teachers and students is the essential soft power for driving this transformation, forming a critical support for building a high-quality PE system and cultivating talent.

From the teachers' perspective, the promulgation of the Teachers' Digital Literacy framework by the Ministry of Education in 2022 establishes quality standards across five dimensions: awareness, knowledge and skills, application, social responsibility, and professional development. This framework accelerates the necessary evolution of the PE teacher's role in the era of "Internet + Education," transitioning from traditional skill imparters to practitioners of digital skill instruction. Empowered by digital teaching platforms and training in new pedagogical models, physical education teachers can establish digital teaching mindsets, master the latest knowledge and skills, and continually strengthen their digital literacy through practical application.

From the students' perspective, developing digital literacy is crucial for their growth in an increasingly digital world and is a necessary measure for advancing the digital transformation of higher education. The Outline of Action for Improving Digital Literacy and Skills for All (2021) explicitly integrates digital literacy cultivation into educational activities. Therefore, the comprehensive promotion of digital teaching also provides the foundational support for enhancing students' digital competencies.

3.3 Leveraging the Digital Economy to Optimize the Teaching Environment

The digital economy plays a vital role in rejuvenating and optimizing the college physical education environment. Firstly, it addresses the shortcomings of the digital sports teaching system. The deep integration of the digital economy and education, guided by relevant national policies, marks a new stage of transformative development in educational informatization. This trend not only promotes overall educational digitization but also encourages the introduction of specific policies for the digital transformation of physical education, creating a favorable institutional environment and enhancing systemic guarantees for its effective implementation.

Secondly, the digital economy expands the coverage and accessibility of digital sports resources. While many universities struggle to fully support digital sports development with existing resources, the optimal allocation and integration of digital and traditional resources can compensate for these shortages. This applies to various aspects, including funding for equipment renewal, teaching activities, and scientific research. Moreover, the expansion of the digital economy facilitates the establishment of resource cloud service platforms for sharing and trading digital PE teaching resources. This enables resource co-creation and crowdfunding, breaking down the barriers of the traditional, isolated model of resource production and use. Consequently, students can effectively integrate online and offline resources based on their individual needs, transitioning from "dedicated resource services" to a comprehensive "big resource service" model.

4. The Realistic Dilemma of Digital Transformation of Physical Education in Colleges and Universities

4.1 The Digital Divide in Physical Education Caused by Uneven Intelligent Resource Allocation

The application of digital technology has gradually shifted from specific to general fields, narrowing the spatiotemporal limitations of college physical education. However, the uneven allocation of intelligent digital resources in college physical education remains significant, leading to a digital divide^[5]. First, the updating of digital technology in physical education is lagging. With the development of information technology, its iteration cycle is becoming shorter. Emerging digital technologies and equipment continue to empower college education, posing new requirements for the digital reform of physical education. Yet, the new infrastructure for physical education in colleges and universities is relatively backward in terms of technical level. For example, current college physical education is still in the primary stage of digital reform regarding intelligent digital equipment and the application of digital technology. Second, there is a gap in the digital practice of physical education teaching. The construction of new intelligent facilities, with digital technology as the core and innovation as the driving force, often reflects the most advanced and efficient technical concepts. However, sports intelligent technology involves cross-domain achievement transformation, facing problems such as complex operation and unfriendly interfaces, making it difficult to apply directly in the field of college physical education.

4.2 Lack of Digital Literacy among Teaching Subjects Due to Technological Iteration

The lack of digital literacy makes it difficult to leverage digital sports as a technical tool for teaching and learning, affecting the initiative for digital transformation in physical education. First, there is insufficient digital application by teaching subjects. In recent years, the iterative updating of advanced technology in physical education teaching digitization has made the advantages of digital physical education teaching obvious. However, empowering new technologies requires the main body of physical education to possess corresponding information application capabilities. In the process of digital transformation in higher education, physical education teachers have failed to shoulder the mission of digital transformation based on the openness, complexity, and collaborative sharing characteristics of digital teaching^[6]. Since 2020, college physical education teachers still focus on

traditional offline teaching, have not formed teaching habits involving digital technology intervention, and have not fully utilized digital technology to guide and cultivate their own and students' digital thinking. Second, there is insufficient digital cognition among teaching subjects. With the progress of educational concepts, the development of college physical education towards informatization and digitization has become an inevitable trend of teaching reform. As the application of digital technology in college physical education is still in its infancy, most physical education teachers' and students' digital thinking remains superficial or formalistic regarding information technology.

4.3 The Backward Digital Environment Caused by Weak Penetration of Digital Concepts

The weak penetration of digital concepts still leads to isolated islands in the digital physical education system environment and cultural environment within colleges and universities, constraining the digital transformation of physical education. First, the weak supply of oriented policies has become an obstacle. The digital environment centered on digital concepts is an important factor promoting the digital transformation of college physical education. In recent years, successively issued digital policy documents seem to provide environmental support for the digital transformation of colleges and universities, but they do not directly address the digitization of the physical education teaching field. They have not played a practical role in penetrating digital concepts into college physical education teaching and lack targeted action strategies. Second, traditional teaching concepts have become a deviation. Currently, the form of physical education in colleges and universities still leans towards the traditional^[7]. Even though colleges and universities continuously promote the penetration of digital concepts through online course training, the teaching concept of 'working in isolation' has been long-established. The deviation in conceptual value from the digital era has led to unsatisfactory effects in the digital transformation of college physical education.

5. The promotion path of digital transformation of physical education in colleges and universities

5.1 Increase Technological Investment to Bridge the Intelligent Gap

Firstly, it is essential to build intelligent technology for physical education teaching. This can be achieved by, first, establishing collaborative channels for industry-education integration. By leveraging the strengths of digital enterprises, intelligent equipment and physical education can be deeply transformed. Through school-enterprise cooperation, new technologies, equipment, and methods should be actively explored to develop intelligent virtual sports simulation environments and establish sports simulation platforms, thereby enhancing the digital foundation of physical education teaching. Secondly, the digital infrastructure for college physical education must be consolidated. The government should increase support for technological investment in physical education teaching, establish and improve cloud libraries for digital physical education resources, and enhance innovative pathways for colleges to actively promote the digitization of physical education based on the principle of 'integration'.

Furthermore, digital sports practices need to be innovated. Firstly, by combining differentiated innovation in physical education curricula, specialized digital equipment can be introduced according to different course projects. This will enhance the integration of interdisciplinary technologies like VR and AR, assisted teaching robots, into physical education. Digital technology can thus 'pave' the way for sports specialization, realizing practical models such as 'dual-teacher instruction,' multi-party coordination, and spatiotemporal coordination. Secondly, achieving the cross-border integration of new technologies and physical education is key to exploring new avenues for digital transformation. Establishing joint channels among sports departments, education departments, and other relevant entities is crucial. The experience of integrating new technologies from major sporting events should be gradually incorporated into college physical education teaching, facilitating a technological "intelligent transformation" in pedagogy.

5.2 Strengthen Organizational Management and Improve Digital Literacy

Firstly, training channels for 'digital + sports' should be broadened. For teachers, a training model centered on the concept of 'big digital sports' should be adopted. Through online training and offline lectures, teachers' digital thinking, psychological readiness, and application skills in lesson preparation, teaching, and evaluation should be strengthened, with a focus on technical and psychological guidance. For students, investment in 'digital + sports' human resources must be increased. Starting with digital

learning, universities should integrate digital sports resources and embed digital literacy throughout the entire physical education teaching system. Simultaneously, digital media resources should be utilized to enhance student interaction with digital technology during teaching and evaluation.

Secondly, a 'digital + sports' incentive mechanism needs to be established. For teachers, a demonstration incentive mechanism should be created. This could involve adding majors like 'Digital Sports Guidance' and regularly assessing and selecting 'Digital Sports Demonstration Teachers' or 'Advanced Digital Sports Teachers,' rewarding them with salary bonuses, establishing special funds for digital sports innovation, or offering preferential treatment in professional title evaluations. For students, an evaluation incentive mechanism should be developed. This includes creating special scholarships for 'Digital Sports Talents,' moving beyond evaluation criteria based solely on sports performance, and incorporating digital literacy into the criteria for scholarships and awards.

5.3 Optimize the Digital Environment and Guide Conceptual Penetration

Firstly, the construction of the policy system must be strengthened. This involves, firstly, accelerating the establishment of a specialized policy framework. Based on the resources and characteristics of college physical education, tailored digital policy guidance should be refined to meet the specific needs of educational reform, building a policy system grounded in the 'digital + sports' concept. Secondly, the supervision mechanism for digital sports needs improvement as a safeguard. On one hand, colleges should incorporate periodic evaluations into their supervision mechanisms, integrating aspects like digital teaching time, content, and standardization into the physical education teaching supervision system. Appropriate penalties and re-evaluations should be imposed for non-compliance. On the other hand, a fourth-party anonymous feedback platform should be constructed to explore a new model of 'Internet + supervision.' This would enable timely reporting and help curb distortions and perfunctory practices in the digital development and supervision of physical education teaching.

Secondly, the digital teaching environment requires optimization. Firstly, traditional cultural thinking must be overcome. Colleges should be encouraged to develop digitized sports projects with school-based characteristics under the "one school, one product" concept. Characteristic digital sports projects can drive the "reconstruction" of the digital environment and foster a new campus culture of "digital + sports." Secondly, public opinion should be guided positively. The leading role of national pilot demonstrations should be fully utilized. A library of typical cases should be compiled, and success stories of digital physical education teaching in colleges should be accurately reported to promote best practices.

6. Conclusion

Currently, the digital transformation of physical education in higher education remains a crucial topic worthy of in-depth exploration in the era of educational informatization reform. As educational digitalization continues to advance, physical education in universities is progressively transitioning from "traditional teaching" to "digital teaching" in terms of pedagogical paradigms. How to better integrate advanced technologies with physical education practices to optimize teaching outcomes will inevitably require a renewed examination of digital sports development. Based on the TOE theory, this study argues that imbalances in intelligent resource allocation, deficiencies in digital literacy, and the weak penetration of digital concepts have hindered the digital transformation of physical education in higher education, largely validating the reasons for educational digitalization reforms discussed in existing literature. To address these challenges, it is essential to uphold a digital sports mindset, comprehensively cover digital sports resources, and initiate the application of digital sports technologies. These efforts will facilitate the transformation of digital awareness, behaviors, services, and innovation in physical education, ultimately achieving the progression from "traditional physical education" to "digital physical education."

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