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RESEARCH ON DIGITAL LITERACY ENHANCEMENT OF PHYSICAL EDUCATION TEACHERS

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ABSTRACT

In the context of digital transformation, enhancing physical education teachers' digital literacy has become a crucial task in educational development. This study employs methods including literature analysis and case studies to systematically explore the theoretical foundation, practical challenges, and development strategies for improving physical education teachers' digital literacy. The research finds that physical education teachers' digital literacy is a multi-dimensional conceptual system, encompassing digital technology knowledge and skills, teaching design and assessment capabilities, the ability to integrate educational theory with physical education knowledge, and learning and self-development capabilities. The study reveals that current efforts to enhance physical education teachers' digital literacy face challenges such as uneven resource allocation, incomplete training systems, and lack of assessment mechanisms. To address these issues, this research proposes systematic solutions including constructing digital curriculum training systems, integrating and developing educational resources, optimizing digital teaching environments and assessment systems, and strengthening faculty development. The research findings have significant theoretical and practical value for promoting the informatization of physical education and enhancing physical education teachers' digital literacy levels.

KEYWORDS: *physical education teachers; digital literacy; teacher training; digital teaching; education modernization*

1. INTRODUCTION

With the rapid development of information technology, digital education is profoundly transforming traditional teaching models and placing higher demands on teachers. Enhancing physical education teachers' digital literacy has become a crucial topic in the process of educational modernization. Digital literacy refers to teachers' ability to utilize information technology for teaching and professional development in digital environments. Improving physical education teachers' digital literacy not only helps teachers adapt to digital teaching environments but also effectively addresses various challenges in the teaching process, thereby improving teaching quality and efficiency and promoting students' comprehensive development. In the context of digital education, physical education teachers' high-level digital literacy is a core element in achieving modern educational transformation and promoting physical education teaching innovation, holding significant practical importance.

The enhancement of physical education teachers' digital literacy holds importance in multiple aspects. First, it helps teachers better adapt to digital education transformation, integrating digital technology into teaching practice to improve teaching effectiveness and efficiency. Second, digital technology provides rich and diverse resources and tools for physical education teaching, helping teachers design more engaging and diverse teaching content to stimulate students' learning interest and initiative. Additionally, digital education supports personalized learning; through improving digital literacy, physical education teachers can more effectively meet students' individual needs, achieve teaching according to their aptitude, and enhance learning outcomes. Meanwhile, digital technology breaks the temporal and spatial limitations of traditional teaching, creating more possibilities for educational equity and enabling educational resources to be distributed more equitably across different regions. Finally, digital education provides a platform for physical education teachers' continuous learning and professional development; teachers can engage in self-directed learning and innovative practices through digital technology, continuously improving their teaching level and educational capabilities to meet the development requirements of educational informatization.

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The main purpose of this study is to explore the challenges and issues faced by physical education teachers in the context of digital education, analyze in depth the current status of physical education teachers' digital literacy, and explore effective strategies and methods for enhancing digital literacy to promote the deep integration of physical education and digital technology, improve teaching methods, and enhance teaching quality and learning outcomes. To achieve this goal, the research will focus on the following questions: What is the current level of physical education teachers' digital literacy? How is digital technology actually applied in physical education teaching? What problems and obstacles exist in the process of enhancing physical education teachers' digital literacy? And how can effective strategies and measures be implemented to promote the enhancement of physical education teachers' digital literacy? The ultimate goal of the research is to provide physical education teachers with practically valuable support and guidance to promote the digital transformation and modernization of physical education.

The scope of this study encompasses multiple aspects of enhancing physical education teachers' digital literacy. First, through investigating the current status of physical education teachers' digital literacy both domestically and internationally, it examines their performance in aspects such as digital technology knowledge, teaching design and assessment capabilities, ability to integrate educational theory with physical education knowledge, and learning and self-development capabilities. Second, it studies the specific applications of digital technology in physical education teaching, including virtual reality technology, sports data analysis and assessment, remote teaching and online courses, and the integration of electronic resources and multimedia teaching. Finally, it explores the problems and challenges in the process of enhancing physical education teachers' digital literacy and proposes feasible enhancement strategies. This study adopts a combination of literature review and case analysis methods, systematically reviewing relevant research findings both domestically and internationally, and through the analysis of typical cases, summarizing effective experiences and implications. This method can comprehensively and deeply explore issues related to enhancing physical education teachers' digital literacy, providing theoretical support and practical reference for improving physical education quality and promoting educational informatization development.

2. OVERVIEW OF DIGITAL LITERACY

2.1 Definition and Components of Digital Literacy

Digital literacy refers to individuals' comprehensive ability to acquire, process, and apply information using digital technology in the digital era. This ability encompasses not only proficient operational skills in digital tools and technologies but also critical thinking, information awareness, information evaluation capabilities, and the ability to collaborate, communicate, innovate, and solve problems in digital environments (Jahnke & Kumar, 2019). Digital literacy is a core competency for social adaptation and personal development in the digital age, with its primary goal being to enable individuals to participate efficiently and responsibly in digital life and work.

The components of digital literacy are manifested in several aspects: First, basic skills and operational capabilities form the foundation of digital literacy, including computer usage, network browsing, and basic information technology operations (Song, 2018). Second, information awareness and information acquisition capabilities require individuals to accurately identify information needs and extract effective, reliable data from vast amounts of information. Meanwhile, digital literacy also encompasses critical thinking ability, namely the capability to evaluate information authenticity, authority, and reliability, avoiding blind acceptance of information. Furthermore, collaboration and communication abilities are particularly important in digital environments, enabling efficient cooperation and information exchange through digital tools. Finally, innovation and problem-solving capabilities emphasize the role of digital technology in promoting individual creative thinking and solving practical problems (Wang & Yang, 2021).

2.2 Importance of Digital Literacy in Education

In the field of education, digital literacy is a crucial factor in promoting educational modernization and improving teaching quality. First, the proliferation of digital technology has made educational informatization an inevitable trend, and enhancing teachers' and students' digital literacy can effectively promote digital teaching activities (Uğraş, 2020). Teachers with higher digital literacy can more flexibly utilize digital technology, improving educational efficiency and optimizing the use of teaching resources. Meanwhile, students can access richer learning content through digital technology support, stimulating learning interest and enhancing learning outcomes.

Second, digital technology provides important assurance for achieving personalized teaching. Through digital technology, teachers can design more targeted teaching plans based on students' learning abilities and interests, thereby achieving teaching according to individual aptitude. This not only helps meet students' personalized learning needs

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but also creates a more flexible teaching environment for teachers, further improving teaching effectiveness. Additionally, digital technology provides students with a platform for problem-solving and innovation, cultivating their ability to use technological innovative thinking and address complex problems (Jahnke & Kumar, 2019).

Finally, the application of digital technology has profound implications for educational equity. Through digital education, students in remote and resource-scarce areas can also access quality educational resources, narrowing urban-rural educational gaps. Meanwhile, the enhancement of digital literacy provides momentum for teachers' and students' lifelong learning, enabling them to continuously adapt to rapidly changing social demands. The cultivation of this ability is not only a core educational objective but also an important indicator of educational modernization.

2.3 Analysis of Current Digital Literacy Status Among Physical Education Teachers Domestically and Internationally

Chinese physical education teachers' digital literacy levels have improved in recent years but still face numerous challenges. On one hand, some physical education teachers lack awareness of updating digital technology-related knowledge, leading to limited scope and depth in digital teaching applications. Furthermore, the scarcity of digital educational resources in some regions and schools restricts physical education teachers in conducting digital teaching activities (Liang & Xu, 2019). On the other hand, physical education teachers' digital teaching design capabilities and assessment systems still need further improvement. Nevertheless, with the government and educational institutions' increased attention to digital education, relevant teacher training and discussion activities are gradually advancing, creating a positive environment for enhancing physical education teachers' digital literacy.

In comparison, European and American countries are relatively advanced in cultivating and practicing physical education teachers' digital literacy. These countries have invested substantial resources in educational informatization, establishing comprehensive digital teaching training systems that enable physical education teachers to possess higher levels of digital technology knowledge. Through the widespread application of virtual reality technology, sports data analysis, and remote teaching, physical education teachers in European and American countries have accumulated rich experience in teaching design and assessment, meeting students' personalized learning needs (Uğraş, 2020).

In comprehensive comparison, the gap between China and European and American countries in physical education teachers' digital literacy is primarily reflected in resource allocation and teaching practice experience. Although China has made significant progress in digital education reform, it still needs to increase efforts in digital educational resource development, teacher training, and teaching method innovation. The successful experiences of European and American countries demonstrate that through scientific training systems and policy support, the enhancement of teachers' digital literacy can rapidly promote improvements in educational quality.

Therefore, in future development, China should draw upon the successful experiences of European and American countries while combining its actual circumstances to strengthen digital educational resource construction, optimize teacher training systems, and provide more support for the comprehensive enhancement of physical education teachers' digital literacy through international cooperation and exchange. This is not only necessary for educational modernization development but also an important pathway for improving physical education teaching quality.

3. APPLICATION OF DIGITAL TECHNOLOGY IN PHYSICAL EDUCATION TEACHING

3.1 Current Status of Digital Technology Application in Physical Education Teaching

The application of digital technology in physical education teaching has become increasingly prevalent, bringing significant changes to teaching models. First, Virtual Reality (VR) technology is widely applied in physical education teaching. Through VR technology, teachers can simulate real sports scenarios, helping students engage in immersive sports skills training and simulated competitions, thereby improving students' motor perception abilities and technical levels. This technology not only enhances teaching engagement but also strengthens students' learning experience.

Second, digital technology plays an important role in sports data analysis and performance assessment. Teachers can use digital devices such as motion sensors to collect real-time student movement data, including speed, strength, and agility indicators, and develop personalized teaching and training plans through precise data analysis. This precise teaching model makes students' learning progress more scientific and efficient (Jahnke & Kumar, 2019).

Furthermore, remote teaching and online courses have become another significant application of digital technology in physical education teaching. Teachers can achieve sharing of teaching resources through online courses, allowing students to conveniently learn physical education knowledge and skills even from different locations. This teaching model has greatly improved the convenience and flexibility of teaching, particularly suited to the digital needs of modern education (Song, 2018).

Finally, electronic resources and multimedia teaching content have further enriched the forms and content of physical education classrooms. Digital education platforms combine diverse resources such as teaching videos and electronic courseware, allowing physical education teachers to flexibly use these resources to enhance teaching interest and appeal while improving teaching efficiency and student learning outcomes.

3.2 Advantages and Challenges of Digital Technology in Physical Education Teaching

Digital technology demonstrates numerous advantages in physical education teaching. First, digital technology provides teachers with rich and diverse teaching resources, such as virtual reality, teaching videos, and multimedia materials. These resources make course content more engaging, greatly stimulating students' learning interest and initiative. Second, digital technology provides technical support for personalized teaching, allowing teachers to design flexible teaching content based on students' learning characteristics, meeting different students' needs and improving learning outcomes (Wang & Yang, 2021).

Moreover, digital technology significantly improves the efficiency and quality of physical education teaching. Using data analysis tools, teachers can understand students' learning progress in real-time and adjust teaching strategies accordingly. Meanwhile, digital technology has expanded the scope and form of physical education teaching, enabling more students to participate in quality physical education through remote teaching and online courses.

However, the application of digital technology also faces certain challenges. Some physical education teachers are not yet proficient in digital technology, experiencing difficulties in technology learning and application. Additionally, the issue of uneven educational resources remains severe, with many regional schools lacking necessary digital equipment and support. Students' excessive reliance on digital technology is also a major concern, potentially weakening their interest and participation in traditional physical activities. Therefore, it is necessary to maximize the advantages of digital technology through enhanced training, optimized resource allocation, and data privacy protection (Uğraş, 2020).

3.3 Case Analysis of International Physical Education Teachers' Digital Literacy Enhancement

Finland has consistently maintained a leading international position in enhancing physical education teachers' digital literacy, with its "Digital Leap in Physical Education" project being particularly noteworthy. Led by the Finnish government, this project aims to comprehensively improve physical education teachers' digital technology capabilities and digital teaching design levels through nationwide teacher training programs. The project adopts a combined online and offline training model to maximize resource coverage and utilization efficiency. The training content includes not only basic digital technology application skills but also focuses on optimizing digital teaching design, providing teachers with practical opportunities through numerous real cases and simulated scenarios.

Meanwhile, the Finnish government places high importance on sharing and disseminating quality teaching resources, constructing a digital resource sharing platform that encourages teachers to upload and exchange course designs and teaching materials. This platform-based sharing mechanism greatly improves resource utilization efficiency while providing convenient conditions for teacher collaboration. Additionally, the application of Virtual Reality (VR) technology is another highlight of the project. Through the introduction of virtual reality equipment, students can immersively experience various physical activities and simulated sports scenarios, not only increasing their learning interest but also enhancing their practical mastery of physical skills. These multi-dimensional innovative measures provide strong support for the comprehensive enhancement of physical education teachers' digital literacy, resulting in significant achievements in Finland's digital transformation of physical education.

American universities provide systematic support for cultivating digital literacy among physical education teachers and students through developing and applying comprehensive digital teaching platforms. These platforms integrate rich resources including teaching videos, multimedia materials, and digital libraries, creating an open and flexible learning environment for students and teachers. Students can not only access high-quality physical education teaching

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content anytime and anywhere but also achieve personalized control of learning progress through the platform, fully utilizing the advantages of online courses and remote teaching. This flexible learning approach both adapts to students' individualized learning needs and provides teachers with greater course design space.

Furthermore, digital teaching platforms integrate assessment and feedback functions. Students can receive immediate learning evaluations and improvement suggestions through online tests and assignment submissions, while teachers can deeply understand students' learning progress and problems through the platform's data analysis tools, thereby making timely adjustments to teaching strategies. Notably, American universities actively introduce virtual reality technology in digital teaching platforms, allowing students to participate in different sports scenarios and practical activities through virtual reality equipment, significantly enhancing their learning interest and experience quality. This innovative measure not only cultivates students' practical operational abilities in digital technology but also further deepens their understanding of physical education theory and practice, laying a solid foundation for future digital physical education teaching work (Uğraş, 2020).

4. KEY ELEMENTS OF PHYSICAL EDUCATION TEACHERS' DIGITAL LITERACY

4.1 Digital Technology Knowledge and Skills

Digital technology knowledge and skills are fundamental elements of physical education teachers' digital literacy, including understanding and application abilities for digital devices, software tools, and teaching platforms. Research shows that physical education teachers' digital technology knowledge system should encompass three levels: basic technical knowledge, professional application knowledge, and innovative development knowledge. Basic technical knowledge includes fundamental skills such as computer operation, network application, and information retrieval; professional application knowledge focuses on the use of digital tools and platforms related to physical education teaching; innovative development knowledge emphasizes the exploration and innovative application of new technologies.

From the perspective of skill development, physical education teachers need to master various digital teaching tools. For example, the application of Virtual Reality (VR) technology in sports skills teaching requires teachers not only to operate VR equipment but also to design appropriate teaching content and assessment plans. Meanwhile, teachers also need to possess data analysis capabilities, being able to collect and analyze students' movement data using various teaching software to provide a basis for teaching decisions.

At the practical level, physical education teachers' digital technology capabilities often exhibit differentiated characteristics. Research finds that young teachers generally surpass senior teachers in digital technology acceptance and application abilities but lack depth in integrating technology with teaching content. This phenomenon indicates that the cultivation of digital technology knowledge and skills needs to combine with educational teaching theory and practical experience to form a systematic capability structure.

4.2 Teaching Design and Assessment Capabilities

4.3 Integration Capabilities of Educational Theory and Physical Education Knowledge

The ability to integrate educational theory with physical education knowledge reflects teachers' level of organically combining professional knowledge with digital technology. This capability requires teachers to not only be familiar with physical education subject knowledge and educational theory but also be able to innovate teaching methods using digital technology. Research shows that successful digital physical education teaching is often built on a solid foundation of subject knowledge, optimizing the presentation and effective delivery of teaching content through technological means.

From the perspective of knowledge integration, teachers need to master integration capabilities at three levels. First is the integration of content knowledge and technology, namely how to better present and teach physical education knowledge using digital technology; second is the integration of teaching methods and technology, including how to innovate teaching models using digital tools; finally is the integration of learning evaluation and technology, focusing on how to achieve more scientific learning assessment through digital means.

In practice, teachers' knowledge integration capabilities are often reflected in the innovation and effectiveness of teaching design. For example, some teachers can cleverly use virtual reality technology to simulate complex sports scenarios, helping students more intuitively understand technical movement essentials. This integration not only improves teaching effectiveness but also promotes students' learning interest and participation.

4.4 Learning and Self-Development Capabilities

Learning and self-development capabilities are key elements for the continuous enhancement of physical education teachers' digital literacy. In the rapidly changing digital era, teachers need to possess the willingness and ability for continuous learning, constantly updating their knowledge structure to adapt to educational technology development. Research shows that teachers with stronger learning abilities more easily accept and utilize new technologies, demonstrating more outstanding performance in teaching innovation.

From the perspective of lifelong learning, teachers' self-development encompasses three key aspects. First is the updating of professional knowledge, including the continuous accumulation of physical education subject knowledge and educational technology knowledge; second is the improvement of practical abilities, emphasizing the continuous summarization of experience and optimization of teaching methods through teaching practice; finally is the cultivation of innovation awareness, encouraging teachers to explore the teaching application value of new technologies.

Establishing an effective learning support system is crucial for promoting teachers' self-development. This includes providing diverse learning resources, building professional exchange platforms, and establishing incentive mechanisms. Research finds that teachers participating in professional learning communities often demonstrate stronger innovation awareness and higher teaching efficacy.

5. STRATEGIES FOR PROMOTING PHYSICAL EDUCATION TEACHERS' DIGITAL LITERACY ENHANCEMENT

5.1 Curriculum Setting and Training System Construction

Scientific curriculum setting and comprehensive training systems are fundamental guarantees for enhancing physical education teachers' digital literacy. From the perspective of curriculum setting, it is necessary to construct a multi-level, systematic training curriculum system. The basic level focuses on cultivating teachers' digital technology operational capabilities; the advancement level emphasizes improving teaching design and practical capabilities; the development level focuses on cultivating innovative application abilities (Sun & Ma, 2020).

The construction of training systems should follow the principles of "demand-oriented, practice-driven, and continuous development". First, training content should be designed based on teachers' actual needs, avoiding disconnection between training and practice. Second, practical training should be emphasized, improving training effectiveness through case analysis and teaching practice. Finally, a continuous training mechanism should be established to ensure teachers can constantly update their knowledge and skills.

From an implementation pathway perspective, a blended training model combining online and offline approaches can be adopted. Online training can provide flexible learning time and rich learning resources, while offline training focuses on practical operation and experience exchange. Meanwhile, a training effectiveness evaluation mechanism should be established, ensuring training quality through assessment and certification.

5.2 Digital Integration and Development of Educational Resources

The digital integration and development of educational resources is an important foundation supporting the enhancement of physical education teachers' digital literacy. From the perspective of resource construction, several aspects need key attention. First, the development of quality digital teaching resources should be strengthened, including teaching videos, virtual reality courses, and online assessment tools. Second, resource sharing mechanisms should be established to promote regional circulation and effective utilization of quality resources. Finally, attention should be paid to the localization of resources, ensuring their adaptation to different regions' teaching needs.

Several key issues need attention in the resource integration process. First is quality control of resources, requiring the establishment of strict resource review and access mechanisms. Second is the assessment of resource applicability, ensuring resources can meet teaching practice needs. Finally is the support service for resource utilization, providing teachers with necessary technical guidance and application training.
From a long-term development perspective, resource update and maintenance mechanisms also need to be established. This includes regularly evaluating resource usage effectiveness, timely updating outdated content, and continuously supplementing new teaching resources. Meanwhile, teachers should be encouraged to participate in resource development, forming a positive cycle mechanism for resource construction.

5.3 Establishing Digital Teaching Environments and Assessment Systems

The construction of digital teaching environments and improvement of assessment systems are important supports for ensuring the enhancement of physical education teachers' digital literacy. From the perspective of environment construction, attention needs to be paid to both hardware facilities and software platforms. Hardware facilities include network infrastructure, multimedia teaching equipment, and virtual reality equipment; software platforms include teaching management systems, learning analysis platforms, and resource sharing platforms.

The construction of assessment systems should follow principles of scientific validity, operability, and development potential. First, reasonable assessment indicators should be determined, including digital technology application ability, teaching design level, and innovative practice capability. Second, diverse assessment methods should be established, combining process evaluation and summative evaluation. Finally, attention should be paid to the application of assessment results, using them as important references for teachers' professional development.

From an implementation strategy perspective, the "promoting construction through evaluation and promoting reform through evaluation" approach can be adopted to advance digital teaching environment construction. Problems are discovered through regular assessment to continuously optimize environment construction plans. Meanwhile, teacher feedback should be valued, promptly resolving technical issues and usage difficulties encountered in practice.

5.4 Faculty Team Building and Incentive Mechanism Optimization

Faculty team building and incentive mechanism optimization are important guarantees for enhancing physical education teachers' digital literacy. From the perspective of team building, strategies of layered cultivation and focused training need to be adopted. For key teachers, focus should be placed on enhancing their innovative application abilities and demonstration leadership roles; for general teachers, emphasis should be placed on improving their basic application abilities and teaching practice capabilities.

The optimization of incentive mechanisms should unfold across multiple dimensions. First is in professional title evaluation and position promotion, making digital literacy level an important evaluation indicator. Second is in performance assessment, setting reasonable assessment indicator systems to incentivize teachers to actively apply digital technology. Finally is in excellence selection, establishing special awards to recognize teachers who demonstrate outstanding performance in digital teaching innovation.

From the perspective of long-term mechanism construction, teacher development support systems also need to be established. This includes providing professional guidance and technical support, building teacher exchange platforms, and organizing teaching research activities. Through various forms of support measures, help teachers overcome difficulties in digital teaching and continuously enhance professional capabilities.

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