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Research on Digital Transformation and the Construction of Physical Education Teacher Resource Ecosystem

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Abstract: The digital wave is sweeping the world at an unprecedented speed, profoundly changing the development pattern of various fields. Under the strong impetus of relevant policies, the education sector has also entered a critical period of digital transformation, which presents both opportunities and challenges for teacher development. Against this backdrop, the construction of the teacher resource ecosystem, especially the optimization and reshaping of the physical education teacher resource ecosystem, has become increasingly important and urgent. This study focuses on this, delving into the rich connotations, core components and dynamic evolution characteristics of the physical education teacher resource ecosystem in the context of digital transformation, and dissecting in detail the many practical problems and deep-seated challenges in terms of concepts, technologies, resources and evaluations in the current

process of building the physical education teacher resource ecosystem Based on this, we have explored practical approaches and multi-dimensional development strategies. Through systematic theoretical reasoning and practical path analysis, it aims to provide solid theoretical support and powerful practical guidance for effectively improving the quality of education and teaching in the new era, vigorously promoting educational equity and balanced development, and fully advancing the modernization and intelligentization process of education. In order to help the education sector achieve intrinsic and high-quality development in the surging wave of digital transformation, especially in the application of digital technology to enhance physical education teaching skills, to achieve scientific and personalized training guidance, to promote the wider and deeper popularization and implementation of national fitness activities, and ultimately to cultivate more people who have solid professional qualities, With the ability to skillfully use digital tools for teaching innovation and research, we aim to produce high-quality, versatile sports professionals who can better adapt to the strategic needs of national development in the new era.

Keywords: Digital transformation; Teacher resource ecosystem; Physical education; Quality of education; Educational equity

In the context of globalization today, the digital wave is reshaping the development pattern of all sectors of society at an unprecedented speed. Education, as the core area for cultivating talents, has seen its digital transformation rise to national strategy. The Outline of the 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China explicitly states that we should accelerate digital development, enhance the level of educational informatization, promote the construction of smart campuses, and build a high-quality education system to meet the demand for innovative talents in the new era. The 14th Five-Year Plan for National Education Development further emphasizes promoting educational equity and quality improvement through the digital transformation of education, cultivating innovative talents that meet the demands of the new era, and providing a solid talent support for economic and social development.

The transformation of educational informatization has promoted the diversification of teaching forms, enhanced the interactivity and personalization of teaching methods, and greatly expanded the presentation and sources of teaching resources. Especially in the field of physical education, motion capture technology, VR/AR technology-assisted skill learning, real-time monitoring and analysis of sports data by wearable devices, online tactical discussions, etc., are making up for the deficiencies of traditional physical education teaching and providing new ways to optimize teaching effectiveness. The unique elements of physical education teachers, such as superb sports coaching skills, diverse sports expertise, sports safety assurance capabilities, effective use of sports venues and equipment, and connections with local sports associations and professional institutions, are also deeply influenced by digital transformation.

Today, although there have been breakthroughs in the digital transformation of education in our country, the development predicaments it faces still need to be further addressed. In the

field of sports, due to the central position of skill practice, the effective application model of digital tools is not yet mature; There are difficulties in ensuring a stable network environment in outdoor activities and expansive sports Spaces; And issues such as privacy protection and ethical norms for sports data constitute unique challenges for the digital transformation of physical education. At present, there are significant disparities in the construction and utilization of digital facilities between urban and rural areas and among regions in China, and there is a lack of norms for the training of teachers' digital literacy. At this point, exploring the issue of digital transformation and the construction of the teacher resource ecosystem, and studying the relationship between digitalization and the teacher resource ecosystem, not only has theoretical exploration value, but also has practical significance for research and practical guidance.

1 The connotation and characteristics of the teacher resource ecosystem under digital transformation

1.1 The connotation of the teacher resource ecosystem under digital transformation

The meaning of the teacher resource ecosystem in the context of digital transformation is an organically unified ecosystem of a multi-element, dynamic and complex teacher resource system. From the perspective of individual capabilities of teachers in the context of digital transformation, individual capabilities of teachers in the context of digital transformation refer to the fact that teachers must have solid subject knowledge and teaching practice ability, teachers' digital capabilities, as well as solid digital literacy. For teachers, there are many predicaments in the process of digital transformation, among which the improvement of digital literacy is a major one.[1] For physical education teachers, in addition to solid subject knowledge and teaching practice ability, they should also have a high level of athletic skills, tactical literacy, training theory, knowledge of sports medicine and nutrition, anti-doping knowledge, etc. Digital transformation supports the acquisition and renewal of physical education teachers' professional capabilities through online professional training, the application of motion analysis software, and VR simulation teaching to enhance practical guidance capabilities. From the perspective of policy logic, policy orientation is an important guarantee for the optimization of teaching resources for teachers.[2] Digital teaching resources in the field of sports include technical demonstration videos of outstanding athletes, interactive tactical learning courseware, sports research databases, popular science materials on sports injury prevention, etc.

The external environment of teacher-student resources includes both on-campus and off-campus environments. Under digital transformation, emphasizing both on-campus and off-campus environments and creating an open and shared environment in the context of information technology is conducive to the construction of an ecosystem of teacher-student resources. Social support is an important external guarantee for the orderly operation of the teacher resource ecosystem. Policies, family education, community resources, and business cooperation are the main contents of social support.

1.2 New characteristics of the teacher resource ecosystem given by digital transformation

The digital transformation of the teacher resource ecosystem has new ecological characteristics of data-driven, intelligent and personalized, bringing new possibilities and space for the professional growth of teachers. At the same time, digital transformation also provides a solid support foundation for the construction of the teacher team, the cultivation of the spirit of educators, and the power given to teachers by the new requirements of the country:

Data-driven precision empowers teaching decisions. Data-driven precision support can effectively facilitate the intelligentization of teaching decisions by teachers. Data-driven

precision teaching can help achieve precise assessment of students and personalized teaching.[3] Through the collection and analysis of students' physical fitness test data, training records, running distance in competitions, heart rate, ball possession rate, etc., personalized exercise prescriptions can be made, training plans can be optimized, teaching methods can be scientifically improved, and early identification of athletic potential can be achieved.

Intelligent assistance for reducing burden, enhancing efficiency and improving quality. The use of intelligent teaching AIDS can achieve high teaching efficiency, help teachers save effort and worry, engage in innovative work and individualized teaching for students,[4] etc. The digital transformation of education at home and abroad also proposes to use technology to optimize the teaching process and enhance teachers' capabilities, injecting new ideas into the construction of the teacher resource ecosystem. [5]Physical education teachers can use artificial intelligence to automatically generate training plans, analyze movement postures in real time and provide feedback, automatically edit highlights of competitions, intelligently group and assign personalized homework based on students' athletic abilities, etc., to enhance the personalization and efficiency of teaching and focus more energy on higher-quality teaching activities.

Personalized growth customizes multiple development paths. Digital transformation provides paths for individual growth and diverse development for teachers and students. Teachers can access personalized learning content and training programs through online learning platforms, educational communities, etc., to achieve self-improvement and professional growth[6]. Use digital platforms to showcase a variety of sports options that fit students' interests, physical conditions, and athletic strengths, or offer specialized online guidance courses for competitive sports reserve talents, and also promote leisure sports content that popularizes the concept of lifelong sports, thereby creating a customized learning environment that maximizes individual potential.

Through a detailed analysis of the various dimensions of the impact of digital transformation on the teacher resource ecosystem, the new characteristics of the teacher resource ecosystem given by digital transformation are sorted out, as shown in Table 1.

Table 1: The Connotation and Characteristics of the Teacher Resource Ecosystem under Digital Transformation

Dimensions	Content
Ecosystem components	The teacher resource ecosystem consists of key elements such as individual qualities and abilities of teachers, teaching resources, the environment inside and outside the school, and social support, and these elements are interrelated and interact with each other.
Expanded Sources of information	The Internet provides teachers with a vast amount of educational and teaching information and resources. Teachers can access the latest educational policies, teaching skills, subject knowledge and research results through a variety of online channels.
Diverse teaching tools	Digital technology provides teachers with intelligent teaching tools such as smart teaching systems, VR/AR devices, online teaching platforms, educational software, etc., to optimize teaching interactivity and interest.
Transformation of learning methods	Online learning platforms and online courses provide teachers with abundant learning resources and flexible learning methods, driving teacher learning towards autonomy, personalization and lifelong learning.

Optimization of the evaluation system	Big data analysis and artificial intelligence technologies make teacher evaluation scientific, comprehensive and dynamic, objectively evaluating teachers' work performance and professional development level.
New Features	Digital transformation makes the teacher resource ecosystem data-driven, intelligent, and personalized, facilitating precise teaching, individualized instruction, and promoting individualized professional development for teachers.
Balanced use of resources	Digital technology promotes the sharing of high-quality teaching resources and Narrows the gap in teacher resources between urban and rural areas as well as among different regions.
Digital teaching optimization	Teachers use digital tools to optimize teaching design, improve teaching quality and efficiency, and reduce waste and inefficiency of traditional teaching resources.

2 The impact of digital transformation on the ecosystem of teacher resources

Under the wave of digital transformation, the teacher resource ecosystem is affected in many ways. There have been significant changes in teachers' information sources, teaching tools, learning methods, and evaluation systems, presenting new opportunities for teachers' professional development. The impact of digital transformation on the teacher resource ecosystem is mainly in several aspects.

First, the expansion of information sources. The Internet has broken the boundaries of teachers' access to information, improving the efficiency and accuracy[7] of teachers' access to information. Physical education teachers can use the Internet to quickly and conveniently learn about the latest teaching theories, training methods, sports research achievements, the latest official rule updates of various sports associations, tactical analysis reports of top sports teams, etc., thereby improving the quality and professionalism of teaching content. Smart tools provide strong support for teaching reform and innovation, driving the transformation of teaching models from traditional lecturing to interactive and experiential learning, and enhancing students' enthusiasm and participation in learning.[8] Secondly, the shift in the way of learning. The autonomous learning model meets the needs of teachers at different learning styles and career development stages, which is conducive to the continuous professional growth of teachers. Finally,[9] the optimization of the evaluation system. Digital evaluation tools and platforms make teacher evaluation more transparent, fair and instructive.[10]

3 An analysis of the current situation of digital transformation and the construction of teacher resource ecosystems

3.1 Current status of digital transformation in the field of education

In recent years, certain achievements have been made in the practice of digital transformation in education both at home and abroad. The Chinese government attaches great importance to the digital transformation of education and has introduced policies such as the Education Informatization 2.0 Action Plan. Various regions are actively exploring and practicing. Measures such as smart campuses and educational MOOCs are constantly emerging to improve the quality of education and management efficiency. The establishment of public service platforms for educational resources has effectively promoted the sharing of high-quality educational resources and contributed to educational equity.

In terms of digital infrastructure construction, the development of network infrastructure in some regions, especially in rural and remote areas, lags behind, affecting the digital transformation of education as well as the speed and level[11] of its construction. The complex

physical activities and interpersonal interactions in sports skills teaching cannot be fully reproduced by digital content, and there is still a shortage of high-quality teaching videos and simulation courseware covering various sports, especially for niche sports and traditional sports culture. In addition, there are deficiencies in the content and methods of digital literacy training for teachers, and the evaluation and feedback system of the training effect is not yet complete. Many teachers also lack the ability to use digital technology. Internationally, many countries also attach importance to the digital transformation of education as a national strategy and introduce relevant policies and measures in a targeted manner. For example, the European Union has issued the Digital Education Action Plan to promote the in-depth application of digital technology in education and achieve innovation in teaching models and improvement[12] in educational quality.

However, there are some common problems in the global digital transformation of education. One is the phenomenon of the digital divide; The second is the absence of copyright and resource sharing systems for digital educational resources; Third, teachers are weak[13] in digital skills and technology application as well as teaching integration during digital transformation. A global systematic review of digital transformation in colleges and universities has found that digital transformation faces problems and obstacles such as barriers to technology application and conservative thinking among teachers, which also indicates that global digital transformation in education is complex, multi-dimensional and a systematic subject[14]. Other studies have shown that in the process of digital transformation, the role of university teachers is changing from traditional knowledge transmitters to diverse roles such as learning leaders and digital resource integrators, presenting new challenges[15] to teachers' professional development and the educational support system of schools. A study on the influence of principal leadership on the digital transformation of primary and secondary schools has found that the strategic vision and planning foresight of principals play an important role and have value[16] in promoting the digital transformation of schools.

3.2 The current situation and problems in the construction of teacher resource ecosystems

There is an imbalance in the number and distribution of teachers. One is that although the overall number of teachers has been increasing, the total number of teachers is still insufficient to meet the demands[17] of educational development. For example, the total number of full-time teachers in kindergartens across the country reached 2.9134 million in 2020, while the number of children in kindergartens across the country was 48.18 million in 2020. According to the Standards for the staffing of kindergarten staff (Interim), at least 6.88 million staff would be needed, but the actual total number of staff is only 5.1982 million. There is a significant gap in the scale of the teaching staff. Second, there is a significant disparity in the distribution of teachers between urban and rural areas, with rural kindergarten principals and full-time teachers accounting for only 16.65% of the national total. There is a serious shortage of teachers in rural areas and remote areas. For example, in Fengqiu County, Henan Province, about 3,000 people retired between 2000 and 2015, and only about 1,000 teachers were replenished through programs such as special post teachers. One quarter of the teachers in rural primary schools are substitute teachers hired by the schools themselves. In Tongdao County, Hunan Province, 120 special post teachers were planned, but only about 80 were recruited, leaving some areas with no teachers available and having to rehire retired teachers or have non-professional teachers substitute, which seriously affected the quality of teaching. Third, the teacher structure is unbalanced in terms of subjects. There is a serious shortage of teachers in subjects such as physical education, physics, chemistry, biology and information technology in rural schools, while there are more teachers in subjects such as Chinese and politics. In mountainous primary

schools in Jiyuan City, Henan Province, the proportion of newly recruited novice teachers in mathematics is only 55%. See Table 2 for details.

Table 2 Specific Manifestations of the imbalance in the number and distribution of teachers

Problems	Case	"Influence"
The gap between the total number of teachers and the demand	In 2020, the total number of full-time teachers in kindergartens across the country reached 2.9134 million. However, according to the "Interim Standards for the Allocation of Kindergarten Staff", with 48.18 million children in kindergartens, at least 6.88 million staff members are needed, but the actual total number of staff members is only 5.1982 million.	It has hindered the improvement of educational quality and had a negative impact on the construction of the teacher resource ecosystem.
The urban-rural gap in the distribution of teachers	Rural kindergarten principals and full-time teachers account for only 16.65 percent of the national total; Between 2000 and 2015, there were about 3,000 retired teachers in Fengqiu County, Henan Province, and only about 1,000 teachers were recruited through special post teacher programs. About a quarter of the teachers in rural primary schools were substitute teachers hired by the schools themselves. In Tongdao County, Hunan Province, 120 special post teachers were planned to be recruited, but only about 80 were actually recruited.	In some areas, due to the shortage of teachers, retired teachers have to be rehired or non-professional teachers have to substitute, seriously affecting the quality of teaching.
Teachers have an unreasonable subject structure	In rural schools in a mountainous county in Hunan Province, there is a severe shortage of teachers in subjects such as physical education, physics, chemistry, biology and information technology, while there is a relative	The phenomenon of teaching not what is learned is widespread, resulting in poor teaching outcomes, low student interest in learning, and difficulty in ensuring the quality of subject teaching.

surplus of teachers in subjects such as Chinese and politics. In mountainous primary schools in Jiyuan City, Henan Province, the rate of newly recruited novice mathematics teachers being professionally matched is only 55%.

Among them, the research also found some problems in the construction of the teacher resource ecosystem: First, the quality and ability structure of teachers need to be improved. At present, there are differences in digital literacy among the teaching staff in China. Some teachers have poor application of digital technology and insufficient[18] ability to use digital teaching resources and teaching tools for teaching. Second, teacher training and professional development need to be optimized, and incentive and evaluation mechanisms need to be improved[19]. Third, in terms of teacher incentive and evaluation mechanisms, traditional teacher evaluation mechanisms overly emphasize teaching achievements and academic achievements, and pay insufficient attention to teachers' achievements in the use of digital technology, online teaching, and the construction of educational and teaching resources, making it difficult to objectively evaluate the performance level and professional level [20]of teachers.

Therefore, based on an in-depth analysis and systematic review of relevant theories, policy documents and practical cases, the author has drawn a practical roadmap for the construction of the teacher resource ecosystem in the context of digital transformation, as shown in Figure 1.

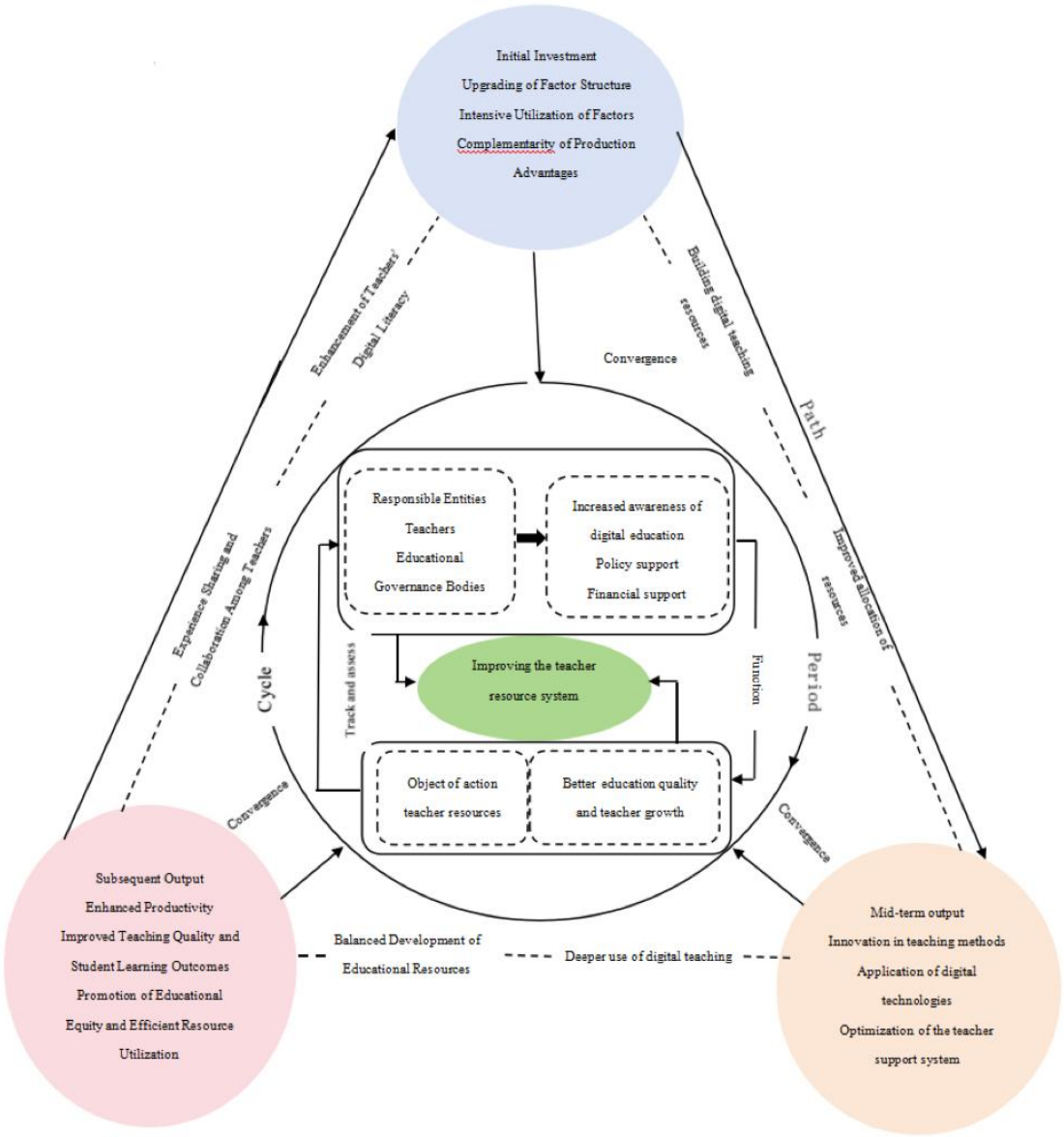

Figure 1 Practice Path Map of Teacher Resource Ecosystem Construction in the Context of Digital Transformation

4 Practical Paths for building a teacher resource ecosystem in the context of Digital transformation

4.1 Enhance teachers' digital literacy and competence

Develop standards and training programs for teachers' digital literacy and competence. Establishing clear standards and curriculum plans is a prerequisite for enhancing teachers' digital literacy, which can effectively align training content with training needs and ensure training quality.[21] At the same time, develop corresponding course training plans to ensure that training is carried out purposefully. For example, organize training on the operation of sports biomechanical analysis software, practice workshops on designing training programs using online platforms, seminars on the application of wearable device sports data in teaching, case studies on the classroom application of VR/AR teaching materials, training on the ethical norms of e-sports coaching, etc.

Carry out a variety of professional training activities for teachers. Organize diverse teacher professional training programs to promote free learning among teachers. Through diverse training activities, the training needs of different teachers can be met, thereby promoting the improvement[22] of digital literacy among all teachers.

4.2 Optimize the allocation and management of teacher resources

Establish a database of teacher resource information. Give full play to the role of information technology in the construction of the teacher resource information database, comprehensively collect basic information of teachers, subject matching information, subject ability information, teaching performance information, etc., and conduct dynamic monitoring of teacher resources.

Use technology to create a model of teacher resource allocation. Further build teacher allocation models based on big data and artificial intelligence technologies, and achieve precise allocation of teacher resources based on data information such as schools, regions, and subjects. Through the resource allocation model supported by technology, effectively enhance the utilization of teacher resources and scientifically allocate[23] teacher resources.

Improve the teacher resource management mechanism. Optimize the allocation of teacher resources and improve the evaluation and feedback of teacher resource allocation. Regularly evaluate and provide feedback on aspects such as student teaching workload and teacher professional development in teacher resource allocation to enable teachers to understand their own teaching situation and actively improve.

4.3 Strengthen the construction and sharing of digital teaching resources

Promote the construction of digital teaching resources. Accelerate the construction of digital teaching resources and support the joint construction and sharing of rich and diverse digital teaching resources by schools and enterprises.[24] Build high-quality multilingual sports skills teaching video libraries (including slow-motion and multi-angle replals), interactive sports rule diagrams, tactical simulation games, graded and categorized physical training method libraries, animated courseware for sports injury prevention and treatment, and digital libraries for Olympic and Paralympic sports education, etc.

Build a digital teaching resource sharing platform. Build a national digital teaching resource sharing platform, gather relevant digital teaching resources, achieve quality resource sharing, build a national digital education resource public service system, achieve national quality resource sharing and push, so that every teacher can access quality teaching resources.

4.4 Innovate teacher evaluation and incentive mechanisms

Improve the teacher evaluation system. Establish a teacher evaluation index system adapted to digital transformation, with the digital teaching and education level of teachers, the quality of online teaching, and the contribution of educational resources as indicators for teacher evaluation. The contribution to the improvement of students' physical health and motor skills, the guidance results for the formation of a healthy lifestyle, the organization and implementation of sports events and activities, the contribution to community sports promotion, the enthusiasm for improving teaching with digital means and the sharing of excellent teaching cases resulting from it are included in the evaluation scope.

Strengthen teacher incentives. Establish a special reward fund for digital transformation, formulate special incentive policies, recognize and reward outstanding teachers and teams that emerge during the digital transformation process, form an effective benefit guidance mechanism, encourage the teaching staff to actively enhance digital literacy and teaching informatization capabilities, and actively participate in the digital transformation of education.

5 Conclusion

In the context of digital transformation, the construction of the teacher resource ecosystem is more distinctive, demanding, and faces more opportunities and challenges. This paper first explains the connotation and characteristics of the teacher resource ecosystem in the context of digital transformation, then studies the current situation and problems of the teacher resource ecosystem in the context of digital transformation, and finally proposes several paths and strategies for practicing the ecosystem construction. It is hoped that this will provide theoretical basis and practical guidance for improving educational quality, promoting educational equity, and advancing educational modernization. It is expected that by enhancing teachers' digital skills and literacy, optimizing resources, strengthening sharing, and innovating evaluation and incentive systems, a dynamic and well-developed teacher resource ecosystem can be cultivated, laying a better foundation for adapting to the development of The Times and cultivating talents needed for future development. Especially for physical education, digital transformation is the key to breaking through the limitations of traditional teaching models, achieving individualized teaching, and cultivating students' lifelong sports habits. The use of smart technology can not only improve the quality of physical education teaching, but also enhance the physical fitness of the people, promote the prosperity of sports culture and the harmonious development of society.

In the context of the transformation and upgrading of educational informatization, there is still a long way to go for the construction of the teacher resource ecosystem. In the future, with the application and popularization of information technology and the advancement of educational and teaching ideas, there will be more and more new problems and new contents in the teacher resource ecosystem. It is necessary for relevant administrative departments, teachers, schools and the whole society to continuously improve the teacher resource ecosystem to promote the healthy development of education in our country.

Competing Contributions

P.G led the study. All authors conceived and designed the study. GP.J drafted the article. All authors made critical revisions to the manuscript for important intellectual content and gave final approval of the manuscript.

Competing interests

The authors declare no competing interests.

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