

Generative artificial intelligence empowering physical education teaching in universities: value implications and practical paths

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Abstract: Digital education is a core direction for the reform of higher physical education. Generative artificial intelligence (GenAI) provides a new technological paradigm to innovate university physical education teaching and improve teaching quality. Based on literature review, questionnaire survey, expert interview and logical analysis, this study takes teachers and students from 30 domestic undergraduate universities as samples to explore the value, dilemmas and mechanisms of GenAI application, and constructs targeted implementation paths. GenAI boosts teaching development in four dimensions, effectively solving problems such as homogeneous instruction, insufficient process evaluation and lack of personalized teaching. Currently, the integration of GenAI and physical education is hindered by teachers' inadequate digital literacy, poor technology scenario adaptation, incomplete data security management and absent ethical norms. These issues result from insufficient digital investment, backward teacher training, imperfect institutions and lagging specialized technological research. This paper proposes an integrated path covering teacher development, scenario integration, security guarantee and ethical governance, aiming to offer theoretical and practical references for the digital transformation of university physical education.

Keywords: generative artificial intelligence; university physical education teaching; digital education; value implications

1 Introduction

1.1 Research background

A series of national strategic policies, including the *Action Plan for Artificial Intelligence Innovation in Institutions of Higher Education* and the *Overall Layout Plan for Building a Digital China*, have clearly put forward requirements to deepen the integration of artificial intelligence and higher education. Digital technologies are expected to lead educational model transformation and comprehensive quality improvement [1]. As an indispensable component of higher education, university physical education undertakes fundamental educational missions: enhancing students' physical fitness, cultivating their awareness of lifelong sports, and shaping healthy personalities and sound moral traits [2].

For a long time, restricted by large class sizes, unreasonable teacher-student ratios and relatively rigid teaching models, university physical education in China has been trapped in structural difficulties. Common problems include homogenized teaching resources, fragmented technical guidance, delayed feedback on learning outcomes and overly simplistic

evaluation systems. These shortcomings fail to cater to college students' diversified physical conditions, sports hobbies and personalized development demands, and greatly restrict the overall educational effectiveness of university physical education [3].

Different from traditional intelligent sports technologies with single functions, generative artificial intelligence is characterized by multimodal content generation, big data analysis and real-time human-computer interaction. It can intelligently produce diversified teaching contents, conduct accurate identification and analysis of sports movements, dynamically track students' learning data, and customize exclusive training schemes for individuals [4]. Such technological strengths provide powerful support for restructuring the whole system of university physical education and breaking through the bottlenecks of traditional teaching [5]. Against the combined background of policy guidance and technological innovation, in-depth exploration on the functional value, practical difficulties and scientific development paths of GenAI-enabled physical education has become an urgent research topic for the digital reform of contemporary university physical education.

1.2 Research review

1.2.1 Overseas research status

International academia conducted research on the integration of artificial intelligence and physical education at an earlier stage. Existing studies mainly focus on the practical application of technologies and the development of diversified intelligent teaching scenarios. Relevant empirical results prove that GenAI can significantly improve the accuracy of skill teaching and professional training through sports data modeling, comparative analysis of technical movements and simulated tactical drills. Many scholars have also verified the application value of intelligent tools in students' independent learning and after-class auxiliary training, and affirmed that human-machine collaborative teaching modes can effectively boost classroom teaching efficiency [6][7].

Nevertheless, most overseas research merely focus on the functional application of technical tools and quantitative assessment of application effects. They pay insufficient attention to the essential educational attributes of physical education, the standardization of application ethics, and adaptive training for teachers. The research perspectives are relatively limited, and the overall research system lacks completeness and comprehensiveness.

1.2.2 Domestic research status

Domestic scholars have carried out extensive discussions and explorations on artificial intelligence empowering physical education teaching in recent years [8]. Current studies mostly elaborate on the practical value and potential risks of technological integration, and put forward preliminary ideas on development paths. Most researchers recognize that GenAI can reshape traditional physical education modes and optimize the allocation of teaching resources, serving as a core driving force for the digital transformation of school physical education [9]. Meanwhile, scholars have also pointed out prominent risks in the integration process, such as teachers' inadequate digital capabilities, low technical adaptability, and hidden dangers of data leakage. Generally speaking, domestic research studies are dominated by theoretical reasoning and qualitative discussion, while large-sample empirical investigations are relatively scarce [10].

Few studies thoroughly analyze the internal operating mechanism of technological empowerment and the deep-seated causes of practical dilemmas. The proposed development paths also lack systematic design and targeted operability, which cannot fully guide the on-site implementation of intelligent physical education reform. Accordingly, there remains sufficient room for further in-depth research in this field.

1.3 Research value and innovation

Theoretically, this research takes specialized physical education teaching scenarios as the starting point, deconstructs

the internal operating logic and multi-dimensional value system of GenAI empowering physical education. It makes up for the common deficiency in current studies that overemphasize technical application while ignoring operational mechanisms, and further enriches and improves the theoretical framework of intelligent physical education and digital education. Practically, based on first-hand empirical investigation data, this study sorts out practical obstacles in the integration of technology and teaching, and builds a four-dimensional integrated implementation path combined with the actual operation of universities. The research conclusions and countermeasures can provide practical guidance for colleges and universities to promote intelligent physical education reform and improve comprehensive educational quality. This research has three major innovations. Firstly, it adopts a combined research paradigm of empirical investigation and theoretical analysis, breaking the limitations of pure theoretical research in previous literature. Secondly, it explores the root cause of practical dilemmas from subjective cognition, objective resources, and institutional construction perspectives, rather than simply listing superficial problems. Thirdly, it constructs a full-process and systematic implementation framework, which takes technical application, teacher development, data security, and ethical norms into overall consideration and boasts stronger practical adaptability.

2 Research objects and methods

2.1 Research objects

This study regards the empowering value and practical application paths of generative artificial intelligence in university physical education teaching as the core research object. The research samples cover 30 universities of different types in eastern, central, and western regions of China, including 328 full-time physical education teachers, 1,126 undergraduate students, and 10 authoritative experts engaged in physical education research. The sampled institutions involve comprehensive universities, normal universities, science and engineering universities, and professional sports universities, ensuring good regional coverage and sample representativeness.

2.2 Research methods

2.2.1 Literature review

This study retrieves core journal papers, academic monographs, and national educational policy documents published from 2023 to 2026 from mainstream academic databases including CNKI, Wanfang Data, and Weipu Database, with retrieval keywords covering generative artificial intelligence, university physical education teaching, intelligent sports, and digital education. By systematically sorting out and summarizing existing research achievements, this study clarifies the technical characteristics of GenAI and its logical connection with physical education teaching, so as to lay a solid theoretical foundation for the construction of the research framework and argument analysis.

2.2.2 Questionnaire survey

In accordance with the research objectives, two versions of questionnaires for teachers and students were compiled respectively. The questionnaire content covered multiple core indicators such as technical cognition, practical application status, digital literacy level, perceived difficulties, and developmental suggestions. Stratified random sampling was adopted to conduct the field investigation. A total of 350 teacher questionnaires were distributed, and 328 valid questionnaires were recovered, with an effective recovery rate of 93.7%. Among 1,200 distributed student questionnaires, 1,126 valid ones were collected, achieving an effective recovery rate of 93.8%. SPSS 26.0 statistical software was used to conduct reliability and validity tests as well as data analysis to guarantee the authenticity and validity of the research data.

2.2.3 Expert interview

A standardized semi-structured interview outline was formulated for this research. In-depth interviews were conducted with 10 senior experts in the field of physical education and 20 frontline physical education teachers. The

interview centered on the practical difficulties in the implementation of intelligent physical education, problems of technical scenario adaptation, deficiencies in institutional construction, and targeted optimization suggestions. This method effectively supplemented the research blind spots of quantitative data and deepened the depth of the research conclusions.

2.2.4 Logical analysis

This research applied multiple logical research methods including induction, deduction, comparison, and comprehensive analysis. It integrated literature materials, survey data, and interview records, systematically analyzed the functional mechanism of GenAI empowering physical education, deeply explored practical dilemmas and their formative causes, and deduced scientific and feasible practical paths, so as to ensure the rigorousness and logical coherence of the whole research.

3 Research results and analysis

3.1 Core value implications of GenAI empowering university physical education teaching

3.1.1 Teaching mode restructuring: building a new human-machine collaborative teaching paradigm

Traditional university physical education generally follows the one-way teaching mode of teacher demonstration plus student imitation, which leads to insufficient classroom interaction and the lack of one-on-one targeted guidance. Relying on multimodal content generation, real-time motion recognition, and intelligent interactive feedback technologies, GenAI completely reshapes the traditional classroom form and constructs a new teaching paradigm featuring teacher leadership, AI assistance, and student-oriented learning. Before class, intelligent systems can automatically generate targeted teaching plans, professional training schemes, and diversified teaching resources for different sports events, greatly reducing teachers' repetitive workload in lesson preparation. During class, the system captures students' sports movements in real time, accurately identifies technical deviations, and gives instant correction suggestions, making up for the shortage of individual guidance caused by large class sizes. After class, virtual simulation scenes are applied to carry out tactical deduction and extended professional training, which expands the boundary of offline teaching scenarios. In general, physical education teaching is successfully transformed from an experience-driven mode to a technology-enabled modern teaching mode.

3.1.2 Teaching supply innovation: realizing the goal of teaching students in accordance with their aptitude

College students show obvious individual differences in physical fitness, sports literacy, and interest preferences, while the unified teaching arrangement in traditional physical education cannot meet the demands of stratified and personalized education. Based on students' physical test data, classroom learning performance, and after-class exercise records, GenAI builds exclusive learning portraits for each student, accurately judges their weaknesses in sports capabilities, and generates personalized exercise prescriptions, targeted training plans, and hierarchical learning resources accordingly. For students with weak physical fitness or overweight problems, the system formulates rehabilitative physical education courses; for students with outstanding sports talents, it designs advanced training programs to tap their potential. This mode abandons the rigid one-size-fits-all teaching arrangement and thoroughly implements the educational concept of teaching students in accordance with their aptitude.

3.1.3 Evaluation system upgrading: constructing a full-process multi-dimensional precision evaluation system

Traditional evaluation of university physical education mainly adopts summative assessment represented by final skill tests and physical fitness examinations. Such an evaluation mode has prominent defects including a single evaluation dimension, missing process records, and strong subjective judgment. GenAI realizes the digitalization and refinement of full-process teaching evaluation. It continuously collects data such as students' classroom participation, movement proficiency, after-class exercise frequency, and physical fitness improvement, and establishes complete digital files for

students' sports growth. Meanwhile, a multi-dimensional evaluation indicator system covering sports skills, physical fitness, learning attitude, team cooperation, and comprehensive sports literacy is established. Quantitative data replaces human subjective judgment, realizing the organic combination of summative assessment and process assessment, quantitative evaluation and qualitative evaluation. The overall scientificity, objectivity, and fairness of physical education evaluation are greatly improved.

3.1.4 Literacy training: cultivating digital core competencies for teachers and students

In the era of digital education, digital literacy has become an essential competency for both physical education teachers and students. For teachers, the popularization and application of GenAI urges them to break away from traditional teaching concepts, and actively learn practical skills such as intelligent tool operation, data analysis and digital resource integration. Teachers' role is transformed from a single skill instructor into a curriculum designer, learning analyst and digital education guide. For students, using intelligent tools to carry out autonomous exercise, correct technical movements and learn sports knowledge can effectively cultivate their digital autonomous learning ability, data thinking and scientific sports literacy. It also promotes the transformation of students' sports concept from simply mastering sports skills to pursuing scientific exercise and adhering to lifelong sports.

3.2 Practical dilemmas of GenAI application in university physical education teaching

3.2.1 Deficient digital literacy and inadequate technology integration capabilities

Survey data indicates that only 28.3% of university physical education teachers can proficiently use GenAI tools to complete teaching design, sports movement analysis and learning situation assessment. 45.7% of teachers can only master basic text generation functions and fail to realize the in-depth integration of technology and professional physical education teaching. Another 26.0% of teachers have limited understanding of GenAI and no practical application experience. Combined with interview results, most universities have not built special training systems for physical education teachers' digital competency. Existing digital skill training mainly targets general technologies, lacking practical operation guidance adapted to professional physical education scenarios. The widespread problem that teachers can operate intelligent tools but cannot apply them to actual teaching severely restricts the realization of technological empowering value.

3.2.2 Low scenario adaptability and insufficient in-depth technology integration

Most existing intelligent sports products are designed for general scenarios, with insufficient customized research and development for professional courses such as basketball, football, track and field and gymnastics. The survey shows that merely 35.1% of universities have built professional intelligent physical education teaching platforms. In most institutions, GenAI is merely applied to basic tasks such as document drafting and courseware production, instead of core teaching procedures including movement correction, tactical simulation and physical fitness monitoring. In addition, GenAI has the inherent problem of algorithm hallucination, which easily leads to wrong sports technical guidance and unscientific training schemes. Teachers have to spend a great deal of time checking and revising relevant contents, which reduces the efficiency of intelligent teaching and hinders the deep integration of technology and physical education.

3.2.3 Weak data security management and prominent privacy risks

The operation of intelligent physical education teaching needs to collect a large amount of sensitive information, including students' physical fitness data, daily sports records and personal basic information. According to interview statistics, 80% of interviewed experts and teachers express strong concerns about data security. At present, most universities have not formulated special management systems for sports-related data, resulting in a series of hidden risks: non-standard data collection, incomplete encrypted storage, weak access control and data leakage caused by third-party platforms. Furthermore, algorithm bias and improper data application may also lead to uneven distribution of teaching

resources and inequitable allocation of personalized training schemes, which will trigger educational inequity.

3.2.4 Inadequate ethical norms and vague technology application boundaries

Up to now, China has not issued special ethical guidelines for the application of generative artificial intelligence in the field of physical education, and most universities lack corresponding management norms and constraint mechanisms. The survey reveals that 62.5% of teachers and students have vague cognition on AI application ethics. In practical teaching, some teachers rely excessively on intelligent tools, which weakens their dominant role in classrooms; some students resort to GenAI to finish training summaries and fulfill their autonomous learning tasks in a perfunctory manner. Besides, paid access barriers and homogenized content of some commercial intelligent tools further widen the gap of educational resources and deviate from the fundamental educational orientation.

3.3 Formation mechanism of dilemmas

From the subjective perspective, some university administrators do not attach enough importance to the digital reform of physical education. They hold the biased view of valuing academic education over physical education and emphasizing hardware construction over practical application, and fail to make systematic development plans for intelligent physical education. Influenced by long-standing traditional teaching ideas, many frontline teachers lack internal motivation for digital transformation and technological innovation. From the objective perspective, most universities allocate limited funding to the digital construction of physical education, with most digital education investment tilted towards key disciplines, leading to backward supporting infrastructure. Meanwhile, artificial intelligence enterprises focus on developing products for universal scenarios, and the research and development of refined technologies targeting university professional physical education progresses slowly, resulting in poor adaptability of intelligent tools.

From the institutional perspective, dedicated policy guidelines, teacher training regulations, data security management systems and ethical supervision mechanisms for intelligent physical education are absent at both national and university levels. The integration of technology and teaching operates without effective institutional constraints and standardized guidance, thus falling into a state of disordered development.

4 Conclusions and practical paths

4.1 Research conclusions

Generative artificial intelligence presents four core values for the development of university physical education: restructuring teaching forms, innovating resource supply, upgrading evaluation systems and cultivating digital literacy. It effectively solves the prominent problems of homogenization, simplification and empiricism in traditional physical education, and acts as an important driving force to promote the high-quality development of university physical education. At present, the integration of GenAI and university physical education is confronted with four major dilemmas: teachers' insufficient digital literacy, low scenario adaptability of technologies, prominent data security risks and incomplete ethical norms. These problems result from the combined influence of subjective cognitive deviation, insufficient objective resources and imperfect institutional guarantee systems, which restrict the empowering effect of intelligent technologies. To realize the in-depth, standardized and efficient integration of GenAI and physical education, it is essential to build a comprehensive and systematic practical reform system.

4.2 Practical paths

4.2.1 Establishing hierarchical training system to consolidate teachers' digital teaching capabilities

Universities should incorporate the cultivation of physical education teachers' digital literacy into the regular teacher development system and build a hierarchical and categorized training mechanism adapted to professional characteristics. For young teachers, basic training focusing on intelligent tool operation, prompt design and learning data analysis shall be

arranged. For backbone teachers, advanced training covering intelligent curriculum design and human-machine collaborative classroom construction will be carried out. Universities can regularly organize special workshops and academic exchange activities together with sports universities and intelligent technology enterprises to promote excellent cases of intelligent physical education teaching. Meanwhile, a sound assessment and incentive mechanism for digital teaching capabilities should be established. The application effect of AI in teaching will be included in teachers' performance appraisal and evaluation standards to fully stimulate teachers' initiative for digital transformation.

4.2.2 Deepening scenario integration to realize the full-process technology application

Colleges and universities need to promote the in-depth mutual adaptation between GenAI and professional teaching scenarios throughout pre-class, in-class and after-class teaching procedures. Before class, intelligent tools are used to integrate classroom scenarios and students' physical data to formulate targeted teaching plans and hierarchical learning resources. During class, motion capture, real-time intelligent feedback and virtual simulation technologies are adopted to carry out technical correction, tactical deduction and interactive teaching, so as to improve the precision of classroom teaching. After class, personalized exercise prescriptions and autonomous learning tasks are automatically generated, and students' exercise performance is dynamically tracked to form a complete closed-loop teaching system. In addition, universities should actively carry out school-enterprise cooperation with AI enterprises to develop customized intelligent teaching tools for track and field, ball games, gymnastics and other sports events, so as to solve the problem of insufficient technical adaptability.

4.2.3 Improving the security guarantee system to build a solid barrier for sports data

Universities shall increase special financial investment in the digital development of physical education, upgrade supporting hardware facilities and intelligent teaching platforms, and set up professional technical operation and maintenance teams to ensure the stable operation of intelligent teaching systems. In strict accordance with the *Data Security Law of the People's Republic of China* and the *Personal Information Protection Law of the People's Republic of China*, a full-process management system for the collection, storage, transmission and application of physical education data shall be formulated. Measures including encrypted data storage and hierarchical access control shall be fully implemented, and regular data security risk inspections and emergency response drills shall be organized. Priority should be given to adopting safe and controllable domestic intelligent platforms to avoid data leakage risks brought by third-party services, and ensure the compliant use of students' privacy data and teaching information.

4.2.4 Improving the ethical governance system to clarify technology application boundaries

Combined with the inherent educational attributes of university physical education, universities shall formulate targeted management specifications for intelligent physical education teaching application, clarify the applicable scenarios, usage boundaries and corresponding main responsibilities of GenAI, and put an end to improper practices such as excessive reliance on technology and using AI to complete learning tasks fraudulently. Ethics education for intelligent physical education shall be integrated into the regular education activities for teachers and students. Relevant knowledge can be popularized through special lectures, typical case warning and classroom infiltration to foster correct technology application concepts. A dedicated on-campus supervision team shall be set up to conduct dynamic supervision over the whole process of intelligent teaching, rectify irregular application practices in a timely manner, balance technological empowerment and educational essence, and promote the standardized and high-quality development of intelligent physical education.

4.3 Research limitations and prospects

This research selects undergraduate universities from multiple regions as research samples, but vocational colleges

and private universities are not included, which leaves room for further improvement on the generalizability of research conclusions. Moreover, this study has not carried out long-term teaching intervention experiments, and the quantitative verification of technological empowering effects is insufficient. In follow-up research, the sampling scope can be expanded to cover different types and levels of universities to enhance the general applicability of research findings. Longitudinal tracking research on teaching practice can be launched to quantitatively analyze the practical effects of intelligent teaching. Researchers can also further explore the integrated application of GenAI, metaverse and virtual reality technologies in subdivided fields such as sports rehabilitation, campus sports events and sports culture construction, so as to continuously expand the development boundary of intelligent physical education.

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Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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