

From "Standardization" to "Precision": Paradigm Transformation and Implementation Pathways of University Physical Education in the Perspective of Artificial Intelligence

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Abstract: With the exponential iteration of intelligent technologies and the deep advancement of education digitalization strategies, physical education (PE) in universities is facing an unprecedented paradigm crisis and transformation opportunity. For a long time, constrained by the educational thinking of the industrial age, university PE has been deeply mired in the trap of "standardization," characterized by uniform teaching objectives, unified teaching content, and singular teaching evaluation, seriously ignoring students' individual differences and diversified development needs. The intervention of Artificial Intelligence (AI) technology, with its powerful data computing power, algorithmic decision-making power, and scene perception capabilities, provides a technological lever to break this deadlock and promotes the transition of PE teaching towards a "precision" paradigm. Based on the theory of paradigm shift, this paper deeply analyzes the logical necessity of the transformation from "standardization" to "precision," pointing out that this transformation is not only a change of technical tools but also a systematic reconstruction of the ontology, epistemology, and methodology of physical education. Furthermore, from the four dimensions of precise learning situation diagnosis, precise teaching intervention, precise teaching evaluation, and precise resource allocation, the article constructs an implementation path for AI-enabled precision PE teaching in universities, and conducts an ethical examination of the risks of technological alienation, aiming to provide a theoretical landscape and practical strategies for the high-quality development of university PE in the new era.

Keywords: Artificial Intelligence, University Physical Education, Standardization, Precision, Paradigm Transformation, Implementation Path.

1. Introduction

In the new journey towards building a leading country in education and sports, university physical education, as a fundamental project for improving national quality and cultivating all-round talents, has become increasingly important. However, examining the current reality of university PE teaching, it is not difficult to find that it is still deeply imprinted with the "standardization" production model of the industrial age. Large-class teaching, unified syllabi, and standardized assessment indicators, although historically solving the problem of "large-scale" popularization of physical education, have become bottlenecks restricting the improvement of teaching quality in an era where the concept of "student-centered" education is deeply rooting. General Secretary Xi Jinping has repeatedly emphasized "teaching students in accordance with their aptitude," and the report of the 20th National Congress of the Communist Party of China explicitly proposed to "promote the digitalization of education," pointing out the direction for the reform of university PE teaching.

Artificial Intelligence (AI), as a strategic technology leading a new round of scientific and technological revolution, is profoundly reshaping the form of education. Different from previous Computer-Assisted Instruction (CAI), AI possesses core advantages such as deep learning, cross-media perception, and human-machine collaboration. It can penetrate the surface phenomena of physical education

teaching, precisely capture students' movement behavior characteristics and physiological and psychological data, thereby achieving a precise match between teaching supply and student needs. Moving from "standardization" to "precision" is not only an inevitable choice to solve current realistic pain points such as the decline in students' physical fitness and poor mastery of sports skills but also a necessary move to conform to the trend of personalized education development in the intelligent era.

This paper aims to transcend the perspective of pure technology application and examine AI within the grand vision of the paradigm transformation of physical education teaching. By comparing the essential differences between the "standardization" and "precision" paradigms, explaining the internal mechanism by which AI promotes this transformation, and on this basis, constructing a systematic and operable implementation path for precision teaching, we hope to provide deep theoretical support and practical guidance for the digital transformation of university physical education in China.

2. Dilemmas and Reflections: A Realistic Scrutiny of the "Standardization" Paradigm in University PE

The "standardization" paradigm originated from industrial civilization centered on efficiency. Its core logic is to reduce

management costs and expand the scale of education through uniform standards. However, when educational objects become increasingly diversified and educational needs become increasingly personalized, the endogenous defects of this paradigm are exposed.

2.1. Homogenization of Objectives: "One Size Fits All" Ignoring Individual Differences

Under the dominance of the "standardization" paradigm, university PE teaching objectives often show highly homogenized characteristics. Regardless of whether students possess a strong or weak physical foundation, whether their sports interests lie in basketball or yoga, or what their future career plans are, they often have to complete the same compulsory credits and pass the same physical test standards. This "one-size-fits-all" goal setting leads to the coexistence of phenomena where some students are "underfed" while others are "overwhelmed." For students with better athletic talent, low-standard teaching objectives lack challenge, making it difficult to stimulate their desire for deep learning and even leading to weariness; for students with weaker constitutions or movement obstacles, excessively high unified standards become insurmountable gaps, causing them to lose confidence in participating in physical exercise amidst repeated frustration, deviating from the original intention of physical education.

2.2. Static Content: "Textbook-Centered" Detached from Actual Needs

Traditional PE teaching content is mostly presupposed based on fixed textbooks or syllabi, possessing strong stability and closure. Teachers often strictly follow the established schedule, ignoring the generative nature of the teaching scene and the dynamic changes in student status. This "textbook-centered" content supply mode lacks perception and response to students' real-time learning situations. For example, in basketball teaching, even if most students have mastered dribbling skills, teachers may still carry out repetitive exercises step-by-step to complete the teaching progress, resulting in a waste of teaching time. At the same time, standardized teaching content often lags behind the development of the times and changes in student interests. Emerging sports popular among students have difficulty entering the classroom quickly, resulting in a mismatch between supply and demand, making PE classes synonymous with "boring."

2.3. Unidirectional Process: "Experience Indoctrination" Lacking Precise Feedback

In the "standardized" classroom, the teaching process mainly manifests as the teacher's unidirectional movement demonstration and skill explanation, while students are in a position of passive imitation. Due to the large class size, it is difficult for teachers to observe and correct the movement details of every student in real-time. Teachers' guidance often relies on naked-eye observation and subjective experience, and feedback information is often vague and lagging. For example, a teacher may point out that a student's "running posture is incorrect" but cannot quantitatively point out the specific joint angle deviation or force point error. This "experience indoctrination" lacking precise data support makes it difficult for students to establish correct movement representations, leading to low skill acquisition efficiency and prone to sports injuries due to irregular movements [1].

2.4. One-Sided Evaluation: "Digital Workpoints" Oriented Solely by Results

Evaluation is the baton of teaching. For a long time, university PE teaching evaluation has been deeply bound by "standardization" thinking, relying heavily on summative evaluation and quantitative indicators. The 100-meter sprint time and standing long jump distance in the final exam have become the only yardsticks for measuring students' sports performance, while implicit qualities such as students' effort level, progress range, exercise habit formation, and sports morality during the learning process are often ignored. This "results-only" and "score-only" evaluation system is not only unfair to education—ignoring students' genetic differences—but more seriously alienates the value of sports, guiding students to take exams just to "meet the standard." Once the exam is over, physical exercise stops abruptly, seriously hindering the formation of lifelong sports awareness [2].

3. Theoretical Reconstruction: Connotation and Logic of "Precision" Teaching Paradigm in the Perspective of AI

The "precision" teaching paradigm is not a simple patch to the "standardization" paradigm but a profound revolution based on intelligent technology. It advocates data-driven, algorithm-mediated precise allocation of educational elements and refined reorganization of teaching processes.

3.1. Ontological Reshaping: From "Disciplining the Body" to "Data Twinning"

In traditional physical education, the body is regarded as a physical existence, and teaching is the mechanical disciplining of the body. In the perspective of AI, the ontological basis of physical education has shifted. Through sensing technologies such as wearable devices and computer vision, students' physical attributes such as body shape, functional status, movement trajectory, and even micro-expressions are converted into massive digital signals, constructing a "Digital Twin" corresponding one-to-one with the physical entity [3].

This transformation means that the teaching object is no longer a vague group but a clear, quantifiable "Data Human." Each student's physical shortcomings, skill defects, and psychological fluctuations are made explicit in the form of data. The essence of physical education transforms from "fuzzy shaping based on experience" to "precise intervention based on data." This ontological reshaping provides a logical starting point for precision teaching, making "teaching students in accordance with their aptitude" no longer a utopian educational ideal but supported by a solid technological entity.

3.2. Epistemological Leap: From "Fuzzy Experience" to "Algorithmic Insight"

The core of the "precision" paradigm lies in the precise cognition of the learning situation. Under the traditional model, teachers' cognition of students mainly comes from perceptual experience and scattered observations, which often carry subjectivity and one-sidedness. AI introduces algorithmic models such as deep learning and knowledge graphs, achieving a leap at the epistemological level [4].

Algorithms can process high-dimensional, multi-modal data that the human brain cannot master, discovering hidden associations and laws. For example, through comprehensive analysis of students' physical test data over consecutive semesters, heart rate changes in class, and extracurricular check-in records, algorithms can precisely predict students' sports risks, identify their potential athletic talents, and even analyze the deep-seated reasons for their learning stagnation. This "algorithmic insight" transcends the limitations of teachers' individual experience, providing an objective and scientific basis for teaching decisions, realizing a cognitive leap from "probably maybe" to "precise certainty."

3.3. Methodological Innovation: From "Unified Teaching" to "Adaptive Learning"

At the methodological level, the "precision" paradigm advocates breaking unified time and space restrictions and building an adaptive learning system. The emergence of AI technology, especially Generative AI (AIGC), has endowed the generation and push of teaching content with high flexibility and intelligence.

The adaptive learning system can dynamically adjust teaching paths and difficulty gradients based on students' real-time performance and feedback. If a student shows difficulty in a certain movement link, the system will automatically push breakdown exercises or auxiliary training videos; if a student masters it quickly, the system will increase the challenge difficulty. This "thousand people, thousand faces" teaching method completely changes the passive situation of "people adapting to teaching methods," realizing the active reform of "teaching methods adapting to people." At the same time, the intervention of tools such as intelligent teaching assistants and virtual sparring partners allows personalized guidance to extend to outside the classroom, filling the time gap of traditional teaching.

4. Path Design: Implementation Strategies for AI-Enabled Precision PE in Universities

Moving from a theoretical blueprint to practical implementation requires constructing a full-chain, full-scenario implementation path. This paper proposes starting from four links: learning situation diagnosis, teaching intervention, evaluation feedback, and resource allocation, to create a closed-loop system for precision PE teaching in universities.

4.1. Precise Diagnosis: Building Holographic Multi-Dimensional Student Digital Portraits

Diagnosis is the prerequisite for precision teaching. Universities should make full use of Internet of Things (IoT) and big data technologies to establish a comprehensive data collection and analysis system.

4.1.1. Concomitant Collection of Multi-Source Data

Break the traditional practice of relying solely on annual physical test data and implement normalized and concomitant data collection. Before class, use smart questionnaires to understand students' injury history, sports interests, and psychological expectations; during class, use wearable devices such as smart bands and smart insoles to monitor

heart rate, cadence, and calorie consumption in real-time, and use smart cameras deployed in venues to capture movement trajectories; after class, record exercise frequency and duration through campus running apps. Achieve full coverage of physiological data, behavioral data, and psychological data.

4.1.2. Deep Profiling Driven by Knowledge Graphs

Introduce the knowledge graph of the physical education discipline to structure the collected fragmented data. Through algorithms such as Graph Neural Networks, establish an association model between individual student characteristics and sports knowledge points and skill points. The generated digital portraits contain not only static labels such as height and weight but also dynamic deep labels such as "endurance quality development trend," "basketball shooting stability analysis," and "sports willpower assessment." These portraits will become the "navigation map" for teachers to formulate teaching strategies [5].

4.2. Precise Intervention: Implementing Human-Machine Collaborative Differentiated Teaching

Intervention is the core of precision teaching. Based on diagnostic results, through the human-machine collaboration model, realize the personalized push of teaching content and the refined implementation of guidance.

4.2.1. Intelligent Stratification and Dynamic Grouping

Change the traditional natural administrative class teaching and use AI algorithms to intelligently stratify students based on digital portraits. For students with a weak physical foundation, the system automatically generates a teaching plan focusing on basic physical recovery and interest cultivation; for high-level students, it matches more competitive tactical training content. Moreover, this grouping is not fixed but dynamically adjusted according to students' learning progress, ensuring that every student is always in the "zone of proximal development."

4.2.2. Instant Feedback and Error Correction Assistance

In key links of skill learning, utilize Computer Vision (CV) technology to provide "mirror-style" teaching assistance. For example, in Tai Chi teaching, the large screen displays the comparison of standard movements and student movements' skeletal points in real-time, highlighting limb parts with angle deviations in different colors. Students can immediately see their errors and correct themselves, greatly shortening the skill generalization period. Teachers are liberated from tedious error correction work, focusing on common problems and psychological counseling for special students.

4.2.3. Intelligent Generation of Personalized Exercise Prescriptions

Targeting the shortcomings of students' physical health, the AI system automatically generates personalized extracurricular exercise prescriptions based on principles of exercise physiology. The prescription details the sports items (such as jogging, HIIT), exercise intensity (target heart rate range), duration, and frequency. The system will also automatically fine-tune prescription parameters based on students' daily execution feedback and physical reactions, ensuring the safety and effectiveness of training, truly realizing the concept of "Exercise is Medicine."

4.3. Precise Evaluation: Establishing a Full-Process Data-Driven Evaluation System

Evaluation is the guide for precision teaching. Reconstruct the evaluation system, shifting from single result assessment to precise quantification and value-added evaluation of the entire learning process.

4.3.1. Weight Reconstruction of Process Indicators

Significantly increase the proportion of process evaluation (suggested increase to 50%-60%). Use AI technology to objectively record subtle indicators such as effective exercise density, number of skill practices, and tactical cooperation success rate for each student in every class. As long as students make efforts, even if their final grades do not meet the standard, they can receive affirmation in process evaluation, thereby protecting their enthusiasm for sports.

4.3.2. Algorithmic Implementation of Value-Added Evaluation

Introduce the concept of Value-added Assessment, focusing on students' "own magnitude of progress." By longitudinally comparing students' physical data at the beginning of enrollment with current data, the algorithm calculates their "value-added score." For example, although an obese student still fails the final long-distance running test, if they have lost 10kg and significantly improved cardiopulmonary function through a semester of effort, the system should give them a high score reward based on the algorithm. This evaluation method reflects the fairness and developmental nature of education.

4.3.3. Multi-Modal Comprehensive Literacy Evaluation

Use affective computing and Natural Language Processing (NLP) technologies to attempt to evaluate implicit qualities such as sports morality and teamwork ability. For example, analyze the frequency of interactive behaviors (high-fiving, encouraging teammates) in team match videos, and analyze the emotional tendency of their after-class reflection logs, thereby deriving a more three-dimensional and comprehensive sports literacy evaluation result.

4.4. Precise Configuration: Optimizing Resource Supply Strategies Based on Big Data

Resources are the guarantee of precision teaching. Use big data analysis to achieve optimized configuration and efficient utilization of university sports resources.

4.4.1. Intelligent Scheduling of Venue Resources

Based on the analysis of students' exercise time preferences and venue heat maps, establish a venue intelligent reservation and scheduling system. Predict peak hours and guide students to exercise at staggered times through dynamic point adjustment mechanisms to improve venue turnover rates. At the same time, dynamically adjust equipment procurement plans and venue functional divisions according to changes in students' demand heat for different sports items, avoiding resource idleness or shortage.

4.4.2. Precise Matching of Faculty Strength

Establish a matching mechanism between teacher capability portraits and student demand portraits. Recommend in both directions based on teachers' specialized strengths, teaching styles (strict, amiable) and students' learning preferences. For example, precisely match teachers skilled in rehabilitation training to student groups with a history of sports injuries, offering special rehabilitation

courses to maximize human resource efficiency.

5. Challenges and Responses: Cold Reflections on the Transformation of Precision Teaching

Although artificial intelligence depicts a beautiful blueprint for precision teaching, clear rationality must be maintained during implementation, squarely facing the potential technical ethical risks and practical challenges.

5.1. Data Privacy and Ethical Boundaries

Precision teaching relies on the deep mining of students' personal data, inevitably touching the red line of privacy protection. Lacking strict data governance mechanisms, students' physical privacy, health defects, and even behavioral trajectories may be leaked or abused. Therefore, universities must establish strict data security firewalls, employing technologies such as differential privacy and federated learning to ensure data is "available but invisible." At the same time, establish data ownership and usage boundaries, strictly prohibiting the use of data for commercial purposes or discriminatory evaluation.

5.2. Algorithmic Bias and "Information Cocoons"

Algorithms are not absolutely neutral; their training data and model designs may imply biases. For example, if training samples are mostly based on male athlete data, algorithms may produce deviations in evaluating female students' sports performance. In addition, excessive personalized recommendation may lead to the "information cocoon" effect, confining students to sports items they are good at or like, ignoring the comprehensive development of physical quality. Therefore, an "algorithm review" mechanism must be introduced, and diversity factors implanted in recommendation algorithms to ensure the comprehensiveness and balance of teaching content.

5.3. Technological Supremacy and Humanistic Absence

The core of physical education lies in "cultivating people," a process containing rich emotional exchange, will tempering, and personality edification, which cold code cannot replace. Excessive reliance on technology may lead to the alienation of teacher-student relationships, turning PE classes into "human-machine interaction classes." In the process of promoting precision transformation, the principle of "technology serving people" must be adhered to, emphasizing the dominant position of teachers. Teachers should withdraw from repetitive labor and devote more energy to spiritual motivation, psychological care, and value guidance for students, achieving the perfect integration of technological precision and humanistic warmth.

6. Conclusion

Moving from "standardization" to "precision" is the only way for the reform of university physical education teaching in the AI era and a profound return to the "people-oriented" educational concept. This transformation concerns not only the application of technology but also the reconstruction of the educational ecosystem. By constructing a precision system of diagnosis, intervention, evaluation, and resource

allocation, we hope to solve many chronic illnesses of traditional PE teaching, allowing every college student to enjoy physical education suitable for themselves, enjoying fun, enhancing physical fitness, perfecting personality, and tempering will in personalized sports experiences.

The future has arrived, and progress will be made. University physical education workers should embrace technological changes with an open attitude while maintaining prudent ethical self-consciousness, constantly exploring new landscapes of human-machine collaboration in practice, and jointly writing a new chapter of sports education in the era of digital intelligence.

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