

Pathways for Precision-Oriented Reform of Public Physical Education in Universities Driven by Smart Sports

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Abstract: Against the backdrop of the coordinated advancement of educational digital transformation, the Healthy China Initiative, and the high-quality development of university physical education, public physical education in universities urgently needs to move beyond traditional teaching models characterized by standardization, experience-driven decision-making, and outcome-oriented assessment, and adopt a precision-oriented educational model characterized by data-driven support, individualized adaptation, and continuous improvement. Smart Sports should not be regarded merely as conventional information technologies but as a comprehensive instructional support system that reshapes the operational logic and decision-making mechanisms of physical education by integrating data, intelligent analysis, and feedback regulation. Precision-oriented public physical education in universities emphasizes the utilization of multi-Source data, including student physical fitness, sports skills, classroom participation, extracurricular exercise, and health behaviors, to achieve accurate identification of student learning profiles, accurate diagnosis of instructional problems, precise alignment of instructional content, adaptive regulation of instructional processes, and adaptive regulation of instructional processes. Currently, university public physical education still faces challenges such as data fragmentation, experience-dependent diagnosis, homogenized instructional support, lagging evaluation mechanisms, and deficiencies in data governance and teachers' digital literacy. To address these issues, a closed-loop framework of "data collection–student profiling–intelligent analytics–instructional support–evaluation and feedback" should be established to promote the transition of public physical education from experience-based decision-making to data-informed, evidence-based practice, from standardized instruction to personalized support, and from outcome-focused assessment to process-oriented continuous improvement.

Keywords: Smart sports; University public physical education; Precision-oriented instruction

Online publication: April 26, 2026

1. Introduction

University public physical education is an important component of the higher education talent cultivation system, undertaking the tasks of enhancing students' physical fitness, cultivating interest in sports, promoting healthy lifestyles, and fostering all-round development. For a long time, university public physical education has largely adopted organizational

approaches characterized by unified teaching progress, standardized instructional content, and uniform evaluation criteria. While this model helps maintain instructional order, it tends to overlook differences in students' physical fitness foundations, sports experience, interest preferences, and health needs, resulting in insufficient instructional relevance, appropriateness, and capacity for continuous improvement.

With the widespread application of big data, artificial intelligence, the Internet of Things (IoT), and mobile Internet technologies in education, smart education has gradually become an important direction for promoting educational reform^[1,2]. In the field of physical education, Smart Sports provides new technological conditions for addressing practical challenges in traditional public physical education, such as difficulties in identifying individual student differences, diagnosing instructional problems, monitoring extracurricular exercise, and accurately evaluating teaching effectiveness. The application of physical fitness testing platforms, sports and health applications, smart sports facilities, campus running platforms, and physical education management systems has enabled the continuous recording, dynamic analysis, and timely feedback of students' physical fitness changes, classroom activity levels, extracurricular exercise participation, and health-related behaviors.

Smart Sports is not equivalent to simply introducing intelligent devices, nor does it mean transferring offline physical education classes to online platforms. In this study, Smart Sports refers to a comprehensive instructional support system centered on the educational objectives of physical education. Supported by data collection, intelligent analysis, instructional feedback, and management decision-making systems, it enables the perception, analysis, regulation, and optimization of the entire process of physical education teaching. Its core value lies in promoting the transformation of physical education from an experience-driven model to a data-informed, evidence-based model through technological integration.

Precision-oriented university public physical education does not merely pursue "accuracy" in data collection; rather, it emphasizes appropriate responses to students' individual differences and health development needs throughout the teaching process. Specifically, precision-oriented teaching includes five dimensions: precise identification, precise diagnosis, precise matching, precise regulation, and precise evaluation. Through data analysis, teachers can understand students' physical fitness, motor skills, interests, and exercise habits, identify specific problems related to athletic ability, health risks, and learning participation, and accordingly arrange appropriate instructional content, exercise intensity, and learning tasks. Based on process feedback, teaching can be continuously adjusted, with attention ultimately focused on students' progress and improvements in health status. From a theoretical perspective, precision-oriented teaching represents a reconstruction of the instructional governance model, taking individual differences as its logical starting point, data evidence as the basis for decision-making, and continuous improvement as its operational mechanism.

2. Realistic dilemmas in the precision-oriented reform of university public physical education

2.1. Fragmented data collection and the difficulty of developing student sports profiles

A prerequisite for precision-oriented teaching is a comprehensive understanding of students. At present, student sports data in university public physical education are often scattered across different systems and application scenarios. Effective integration is lacking among physical fitness assessment data, classroom attendance records, course enrollment data, extracurricular exercise data, and motor skill evaluation data, making it difficult for teachers to develop a holistic understanding of students' physical education learning conditions^[3]. Although some universities have established physical fitness testing platforms or sports management systems, the data are primarily used for grade recording, compliance statistics, and administrative management, and are seldom incorporated into instructional decision-making.

The disconnect between data collection and instructional application makes it difficult to systematically reveal differences among students in terms of physical fitness foundations, athletic ability, health risks, exercise habits, and interest preferences. When determining instructional content and exercise intensity, teachers still rely largely on personal experience and immediate classroom observations. As a result, it is difficult to support personalized instruction in

large-scale public physical education courses or to identify potential exercise-related risks in a timely manner. From the perspective of precision-oriented reform, the key issue is not simply a lack of data, but rather a lack of connections among different types of data. If physical fitness assessment data, classroom data, extracurricular exercise data, and course evaluation data cannot be effectively integrated, Smart Sports cannot be effectively transformed into a basis for instructional improvement.

2.2. Experience-based instructional diagnosis and insufficient support for precision decision-making

In traditional public physical education, teachers typically assess students' learning conditions based on classroom performance, test results, and personal experience. In small-class teaching, teachers' experience can play a positive role. However, with the increasing trends toward large-class instruction, elective courses, and the integration of in-class and extracurricular learning in university public physical education, relying solely on experience makes it difficult to gain a comprehensive understanding of students' actual conditions. For example, poor performance in endurance running may result from insufficient cardiorespiratory endurance, a lack of exercise habits, issues related to weight management, sports injuries, or psychological barriers. Without the support of data analysis, teachers may easily adopt homogeneous training approaches, making it difficult to provide precise diagnosis and differentiated guidance.

The value of Smart Sports lies in its ability to conduct integrated analyses of data related to physical fitness assessments, exercise load, classroom participation, skill acquisition, and extracurricular exercise, thereby helping teachers identify specific problems and developmental needs. However, in practice, some physical education teachers lack sufficient ability to understand and utilize data and have limited proficiency in using smart platforms, resulting in situations where data are "collected but not used" or "used without in-depth analysis"^[4]. Experience-based instructional diagnosis is not only a technical issue but also an issue of instructional decision-making. Only by combining data analysis with teachers' professional experience can instructional decision-making in public physical education shift from an experience-based approach to an evidence-supported approach.

2.3. Homogeneous instructional support and insufficient personalized services

University public physical education serves all students, whose backgrounds and abilities vary considerably. Some students have participated in sports for a long time and possess relatively strong physical fitness and motor skills, whereas others have limited sports experience and may even have physical weaknesses or health risks. In traditional teaching, instructors generally implement courses according to a unified teaching plan. Although approaches such as differentiated instruction and elective teaching are sometimes adopted, the criteria for grouping are often relatively broad, and personalized support remains insufficient^[4].

Under Smart Sports conditions, teachers should provide instructional support based on student profiles and diagnostic results and offer differentiated guidance according to individual needs. For students with poor cardiorespiratory endurance, platforms can assist teachers in assigning aerobic exercise tasks. For students with insufficient skill mastery, platforms can provide movement feedback and practice recommendations. For students who engage in insufficient extracurricular exercise, platforms can send exercise reminders. For students with low interest in sports, platforms can recommend activities that better match their interests. However, many universities have not yet established mature data-support mechanisms or comprehensive systems for personalized exercise prescriptions and task delivery. In addition, the connection between some smart platforms and classroom teaching remains weak, making it difficult for teachers to apply platform data to instructional guidance directly. As a result, the precise support enabled by Smart Sports has not yet been fully implemented in teaching practice.

2.4. Result-oriented evaluation and feedback and an incomplete teaching improvement loop

Evaluation in university public physical education has long emphasized outcome-based indicators, such as final skill tests, physical fitness assessment results, classroom attendance, and performance standards. Although such evaluations can

reflect students' learning outcomes at a particular stage, they cannot fully capture students' progress, effort, and changes in health-related behaviors. For students with relatively weak foundations but substantial improvement, evaluation based solely on final performance may reduce their motivation for physical activity. For students with strong foundations but insufficient participation during the learning process, excessive reliance on outcome-based evaluation may also fail to provide effective guidance and constraints.

Precision-oriented evaluation should focus on students' development from the starting point to the end point. Teachers should consider not only students' outcomes but also their learning processes; not only test results but also improvements in health and the development of exercise habits. Smart Sports can record process data related to classroom participation, exercise load, extracurricular exercise, skill practice, and changes in physical fitness^[5]. However, data-supported process evaluation and value-added evaluation systems have not yet been fully established, and evaluation results have not been effectively used to adjust course content or improve teaching quality. Consequently, the instructional loop of "evaluation–feedback–improvement" remains incomplete.

2.5. Insufficient support from data governance and teachers' digital literacy

The promotion of precision-oriented reform through Smart Sports is not merely a matter of technological application but also an issue of institutional governance. Sports-related data often involves information concerning students' physical conditions, exercise trajectories, health risks, and behavioral habits, all of which possess a certain degree of sensitivity. Therefore, when collecting and using such data, universities need to clearly define the scope of data collection, access permissions, and responsibilities for data security^[6]. In practice, some universities place greater emphasis on purchasing platforms and developing technological infrastructure than on establishing supporting institutional mechanisms. Deficiencies in data sharing, privacy protection, platform maintenance, and interdepartmental coordination may hinder the sustainable advancement of Smart Sports reform and increase potential data security risks.

Teachers are the key actors in the implementation of Smart Sports. If teachers are unable, unwilling, or insufficiently prepared to use smart platforms effectively, precision-oriented reform cannot be successfully integrated into classroom teaching. At present, some physical education teachers lack sufficient competence in interpreting sports data, operating intelligent devices, using digital platforms, and designing personalized instructional plans. If universities emphasize technology application without providing corresponding training, workload recognition, and technical support, teachers' workloads may increase, thereby reducing their motivation to participate in reform efforts. Therefore, the precision-oriented reform of university public physical education should not remain at the level of technological application alone but should be advanced within the broader framework of modernizing the instructional governance system.

3. Practical Pathways for smart sports–driven precision-oriented reform of university public physical education

Smart Sports–driven reform of precision-oriented public physical education is not simply the application of multiple technologies. At its core, it involves restructuring the instructional operation mechanism on the basis of a closed data loop. The process follows a sequence of data collection, student profiling, intelligent analysis, instructional support, and evaluation feedback. First, multi-Source data are gathered to accurately identify students' physical conditions, athletic abilities, and exercise behaviors. Second, dynamic student sports profiles are developed to reveal differences in physical fitness, skill acquisition, classroom participation, interest preferences, and health risks. Third, platform-based analytics are combined with teachers' professional judgment to support diagnostic decision-making. Finally, differentiated instruction, personalized task delivery, exercise prescription guidance, and the integration of in-class and extracurricular learning are implemented, with continuous instructional refinement achieved through evaluation and feedback.

3.1. Developing a multi-source data collection system to support accurate student identification

Universities should establish an integrated sports data collection system covering pre-class, in-class, and post-class stages in accordance with the principles of necessity, applicability, and security. Before class, information such as physical fitness assessment results, sport selections, health questionnaires, interest surveys, and previous exercise experience can be collected to gain an initial understanding of students' physical conditions and learning needs. During class, wearable devices, classroom observation records, exercise load monitoring, and skill performance assessments can be used to capture students' participation and exercise status. After class, sports applications, campus running platforms, and extracurricular exercise check-in systems can provide information on students' independent exercise participation and changes in health-related behaviors.

The purpose of building a multi-Source data collection system is to provide a traceable basis for instructional decision-making. In this way, teachers' judgments regarding students' exercise behaviors are no longer based solely on classroom observations or personal impressions but can also draw on objective data. When collecting data, universities should avoid pursuing advanced technologies for their own sake. Instead, priority should be given to information that directly supports instructional decision-making, including physical fitness, exercise load, skill mastery, exercise frequency, classroom participation, and health risks. For most public physical education courses, the key to precision-oriented reform does not lie in the sophistication of equipment but in whether existing systems can be connected so that relevant data can be understood, accessed, and applied by teachers.

3.2. Optimizing instructional decision-making through student sports profiles: From experience-based teaching to data-informed teaching

The purpose of Smart Sports is not to replace teachers with technology but to provide a stronger basis for instructional decision-making. Drawing on student sports profiles, teachers can make more informed decisions regarding teaching objectives, classroom grouping, instructional content, and exercise intensity. For example, in endurance-related courses, students may be grouped according to their cardiorespiratory fitness and responses to exercise load. In ball-game courses, grouping can be based on skill levels and previous sports experience. In physical fitness enhancement courses, different training priorities can be arranged according to individual weaknesses in physical fitness.

The availability of data can gradually shift instructional decision-making from experience-based judgment to data-informed practice. In the past, teachers mainly relied on classroom performance to assess students' conditions, but such judgments were often constrained by limited observation time and personal experience. Smart Sports platforms can provide more continuous and detailed information on students' learning and exercise participation, helping teachers identify issues such as excessive exercise load, insufficient classroom engagement, slow skill acquisition, or inadequate extracurricular exercise. At the same time, data alone cannot guarantee high-quality instruction. Physical education remains closely connected with physical practice, classroom interaction, and motivational support, and teachers continue to play the central role in instructional design, classroom organization, and educational guidance.

3.3. Using intelligent analysis to generate personalized exercise programs and achieve precise content matching

Based on student sports profiles, universities should promote the transition of Smart Sports platforms from data recording tools to instructional support tools capable of generating recommendations. Drawing on students' physical fitness, athletic abilities, interest preferences, and course objectives, platforms can assist teachers in developing personalized exercise prescriptions and learning tasks^[7]. For students with deficiencies in flexibility, upper-body strength, cardiorespiratory endurance, or weight management, targeted exercise recommendations can be provided. For those experiencing difficulties in skill acquisition, platforms can offer movement demonstrations and corrective suggestions. Such support enables teachers to understand students' needs better and provide more targeted guidance.

Personalized exercise programs should extend across pre-class, in-class, and post-class stages. Before class, teachers

can design differentiated tasks according to diagnostic results. During class, exercise intensity can be adjusted based on students' real-time exercise load and skill performance. After class, review tasks, exercise plans, and feedback suggestions can be delivered through the platform, extending physical education beyond limited classroom hours into students' daily health management. Nevertheless, exercise programs must follow the principles of physical education and take students' actual physical conditions into account. Platform recommendations should not be applied mechanically, nor should teachers rely entirely on automatically generated plans. For students with sports injuries, chronic illnesses, or special physical conditions, universities should establish mechanisms for manual review and teacher supervision to ensure that exercise programs remain safe, appropriate, and effective.

3.4. Establishing an integrated feedback mechanism linking in-class and extracurricular activities

Precision-oriented public physical education is reflected not only in pre-class grouping and post-class evaluation but also in ongoing adjustments throughout the instructional process^[8]. Smart Sports platforms can provide real-time information on exercise load, practice intensity, classroom participation, and fatigue status. When exercise intensity is insufficient, teachers can appropriately increase training tasks. When students exhibit excessively high heart rates or obvious signs of fatigue, exercise intensity should be reduced in a timely manner to minimize potential risks. For students who participate less actively or perform poorly in practice tasks, teachers can provide individualized reminders and encouragement based on feedback data.

Extracurricular exercise represents an important extension of university public physical education. Through Smart Sports applications, campus exercise platforms, or physical education management systems, universities can incorporate extracurricular exercise into course support arrangements. Students may complete personalized tasks involving running, strength training, flexibility exercises, ball games, dance and aerobics, or traditional ethnic sports activities, while the platform records their participation. Teachers can review these records regularly and provide feedback when necessary. The effectiveness of linking in-class and extracurricular activities depends on timely feedback, appropriate task design, and reasonable evaluation. Excessive extracurricular requirements should be avoided, and platform-based participation should not become a purely formal activity.

3.5. Improving data-driven evaluation and governance mechanisms to sustain reform

Smart Sports provides important support for the reform of public physical education evaluation. Universities should move beyond evaluation methods that rely solely on final examinations and physical fitness standards and establish a comprehensive system that integrates outcome evaluation, process evaluation, and value-added evaluation^[9]. Outcome evaluation focuses on motor skills and physical fitness levels. Process evaluation pays attention to classroom participation, exercise load, extracurricular exercise, and learning attitudes. Value-added evaluation emphasizes students' progress relative to their own starting points. Evaluation should not simply produce a score; it should also help students recognize their own development and strengthen their motivation to maintain regular exercise.

Data evaluation results should also serve instructional improvement. Based on overall class data, teachers can examine whether course content is appropriate, exercise intensity is reasonable, student participation is sufficient, and instructional objectives have been achieved. At the institutional level, data can help universities understand the effectiveness of different sports programs, teaching practices, and student groups, thereby providing support for curriculum planning, teacher development, facility management, and resource allocation.

From a governance perspective, Smart Sports development should be incorporated into the overall planning of university physical education. Responsibilities should be clearly defined among departments responsible for physical education, academic affairs, information technology, student affairs, facility management, and campus health services so that a coordinated working mechanism can be established. In terms of data governance, universities should follow the principle of minimum necessary data collection and clearly specify data scope, access permissions, retention periods, and privacy protection requirements. With regard to teacher development, greater attention should be given to improving

physical education teachers' digital literacy, particularly in data awareness, platform operation, sports data interpretation, and personalized program design. Corresponding efforts should also be recognized in workload assessment, teaching evaluation, and incentive systems.

4. Conclusion

Smart Sports-driven precision-oriented reform of university public physical education represents an important approach for adapting physical education to the digital transformation of education and the health development needs of students. Its essence lies not in upgrading technological equipment or increasing the number of digital platforms, but in using data as a bridge to reshape the decision-making structure and operational mechanisms of physical education, thereby promoting a transition from extensive management to refined governance.

Precision-oriented public physical education should remain student-centered, supported by data, guided by teachers' professional judgment, and directed toward improving teaching quality and promoting student health. Specifically, precise identification can be achieved through multi-Source data collection; precise diagnosis through student sports profiles; precise support through personalized exercise programs; precise regulation through the integration of in-class and extracurricular activities; and precise feedback through process-oriented and value-added evaluation. At the same time, efforts should be made to strengthen data governance, privacy protection, teacher training, and institutional support.

In the future, universities should avoid viewing Smart Sports simply as an upgrade of technological equipment. Greater attention should be paid to how data can be translated into instructional actions, how platforms can better support student development, and how evaluation can contribute to continuous improvement. Only by integrating technological logic, instructional logic, and educational logic can Smart Sports promote the transformation of public physical education from standardized arrangements to personalized support, from experience-based judgment to data-informed, evidence-based practice, and from outcome-oriented assessment to whole-process education.

Funding

2024 Guangxi Higher Education Undergraduate Teaching Reform Project "Optimization of Feedback Mechanisms and Improvement of Teaching Quality in University Physical Education Reform Based on Big Data" (Project No.: 2024JGA390)

Disclosure statement

The authors declare no conflict of interest.

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