Academic Education Publishing House

Higher Education and Practice Vol. 3 No. 8, 2026

Research on Exercise Data-Driven Reform of Process-Oriented Assessment in College Public Physical Education Courses

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Abstract: To address prominent issues in process-oriented assessment of college public physical education courses, including the hollowing out of assessment content, reliance on experience, and fragmented feedback mechanisms, this study takes the full-process intervention of exercise data as its entry point. It constructs a four-stage driving model comprising data collection, indicator transformation, weight allocation, and feedback loop, and designs a process-oriented assessment indicator system covering four dimensions: exercise load, skill improvement, exercise behavior, and learning participation. The system raises the weight of process-oriented assessment to 65%, responds to individual differences through improvement-margin indicators, and integrates immediate, stage, and semester feedback mechanisms to achieve organic unity between assessment and teaching. The findings indicate that exercise data-driven reform of process-oriented assessment essentially replaces experiential judgment with quantifiable and traceable records of exercise behavior, transforming process-oriented assessment from a formal existence into substantive evaluation and providing an operable technical pathway for assessment reform in college public physical education courses.

Keywords: Exercise Data; Process-Oriented Assessment; College Public Physical Education; Assessment Reform; Data-Driven

1. Introduction

Assessment in college public physical education courses has long been dominated by summative evaluation. A single skill test or physical fitness test score often determines the semester grade, while students' exercise engagement, skill growth, and behavioral changes during the learning process rarely enter the assessment field. In recent years, the policy orientation toward process-oriented assessment reform has become increasingly clear, yet a fundamental dilemma remains in practice: there is a lack of operable data support for determining what to assess, how to assess, and on what basis to assess in process-oriented evaluation. Traditional methods such as classroom observation records and attendance checks collect information at a coarse granularity and along a single dimension, making it difficult to reflect students' true states and dynamic changes during exercise. Li pointed out that process assessment in college public physical education teaching currently suffers from disconnection between assessment content and teaching objectives and from overly simplistic assessment methods, often reduced to a simple combination of attendance and impression [1]. The introduction of exercise data offers new possibilities for overcoming this dilemma. The spread of wearable devices, smart playground systems, and mobile exercise apps has enabled the collection of data such as heart rate, step frequency, exercise duration, and movement standardness to move from sampling to full coverage and from lagged to real-time. Big data technology can provide multi-dimensional and full-process data support for college physical education teaching evaluation, shifting assessment from experiential judgment toward data-driven decision-making [3]. The problem, however, is that data availability does not automatically equate with scientific assessment. How to effectively transform exercise data into assessment indicators, how to design a data-driven weight structure, and how to establish a linkage mechanism between data feedback and teaching improvement remain insufficiently answered. Focusing on this gap, this study attempts to construct a theoretical framework and operational plan for exercise data-driven reform of process-oriented assessment in college public physical education courses.

2. The Realistic Predicament of Process-Oriented Assessment and the Intervention Logic of Exercise Data

2.1 The Realistic Predicament of Process-Oriented Assessment

The predicament of process-oriented assessment in college public physical education is first manifested as the hollowing out of assessment content. Although many colleges and universities allocate a certain proportion of the grade to regular scores, the actual assessment content is still mainly based on attendance, and classroom performance is often scored by teachers' impressions. As a result, process-oriented assessment exists in name only [1]. Exploration of score assessment reform in public physical education courses at higher vocational colleges has likewise found that traditional assessment models overemphasize summative evaluation, while process-oriented assessment lacks clear indicator systems and operable evaluation standards, causing reform to become a formality [2]. Second, the basis of assessment is overly experiential. Teachers' judgments of students' exercise ability rely mainly on limited classroom observation and can hardly capture changes in students' exercise performance across different periods and projects, leaving the reliability and validity of assessment without objective support [3]. A deeper problem lies in the fragmentation of assessment feedback. Assessment results are often provided once at the end of the semester, and students cannot see their accumulated exercise data or progress trajectories during learning, which severely weakens the motivational and diagnostic functions of assessment. Research on process-oriented assessment of college public physical education courses from the perspective of Sunshine Sports has pointed out that the core value of process-oriented assessment lies in continuous attention to and timely feedback on students' learning processes, yet this function is far from being realized in current practice [8]. These three predicaments are intertwined: the hollowing out of assessment content deprives process-oriented assessment of substantive meaning, the reliance on experience undermines its persuasiveness, and the fragmentation of feedback dissolves the educational function that process-oriented assessment should possess. Together, they point to a fundamental problem: process-oriented assessment lacks objective data support that runs through the entire teaching process.

2.2. The Intervention Logic of Exercise Data and Assessment Empowerment

The intervention of exercise data changes the technical foundation of the above situation. Smart sports systems can continuously collect data on students' exercise load, skill performance, and behavioral participation inside and outside class, forming individualized exercise profiles and making the "one student, one plan" assessment model operable in practice. Experimental research based on student physical health monitoring data has shown that, with continuous tracking and feedback from exercise data, students' physical health improvement is significantly greater than under traditional teaching models [4]. From the perspective of assessment methodology, exercise data provide process-oriented assessment with three key supports. The first is continuity: data collection runs through the entire teaching cycle rather than being limited to a few time points, enabling assessment to capture the dynamic trajectory of students' exercise ability development. The second is objectivity: physiological and behavioral data such as heart rate and exercise duration are not disturbed by subjective judgment, providing verifiable factual evidence for assessment. The third is comparability: under the same indicator system, exercise performance of different students and at different stages can be quantitatively compared, laying the foundation for setting improvement-margin indicators. Experimental research on the examination evaluation system of physical education specialized courses supported by learning analytics has confirmed that evaluation systems based on learning analytics can effectively improve assessment precision and the targeting of teaching interventions [5]. Big data technology can provide multi-dimensional and full-process data support for college physical education teaching evaluation, shifting assessment from experiential judgment toward data-driven decision-making. The intervention of exercise data is not simply the superposition of

technical means onto the existing assessment framework; rather, it fundamentally changes the information basis of process-oriented assessment—from reliance on teachers' limited observation and memory to reliance on continuous, objective, and traceable exercise behavior data. This provides the technical premise for process-oriented assessment to move from form to substance.

3. Path Design for Exercise Data-Driven Reform of Process-Oriented Assessment

Exercise data-driven reform of process-oriented assessment centers on establishing a complete transformation chain from data collection to assessment decision-making. This study summarizes it as a four-stage model: data collection—indicator transformation—weight allocation—feedback loop. These stages are progressive: data collection provides raw material for indicator transformation, indicator transformation provides the basis for weight allocation, weight allocation provides assessment conclusions for the feedback loop, and the feedback loop in turn optimizes the direction of data collection and the precision of indicator transformation.

3.1 Data Collection Layer: Standardized Acquisition of Multi-Source Exercise Data

Data collection is the starting point of the driving chain, and its quality directly determines the scientific nature of subsequent assessment. According to different data sources, it can be divided into three categories. The first is classroom exercise data, collected by smart playground equipment and wearable devices, covering heart rate interval distribution, exercise density, and movement standardness scores. The second is extracurricular exercise data, recorded by campus running apps and exercise check-in systems, covering exercise frequency, duration, and distance. The third is physical fitness test data, collected by standardized fitness testing equipment, covering scores and annual changes in various fitness test items [4]. These three types of data are complementary in temporal and informational dimensions and together form a complete profile of students' exercise behavior. Research has emphasized that the application of big data technology in physical education teaching evaluation requires a multi-source data fusion mechanism, as a single data source cannot comprehensively reflect students' exercise learning states [3]. Research on optimization strategies for the evaluation system of primary and secondary school physical education teaching has further pointed out that data collection supported by artificial intelligence technology should follow the principle of being necessary and appropriate, avoiding privacy risks and student resistance caused by excessive collection [6]. Specifically, classroom exercise data collection should be premised on not disrupting normal teaching and should adopt unobtrusive collection methods. Extracurricular exercise data collection should respect students' autonomy and allow them to choose different exercise forms and recording methods. Physical fitness test data should be collected in synchronization with the National Student Physical Health Standard test to avoid duplicate collection. Standardization of data collection also requires unified data formats and interface standards, laying the foundation for subsequent indicator transformation and cross-platform analysis.

3.2 Indicator Transformation Layer: Mapping from Raw Data to Assessment Indicators

Raw exercise data do not in themselves constitute assessment; they must undergo pedagogical transformation. This study proposes a three-layer transformation logic of data—behavior—literacy. At the first layer, raw data are transformed into describable exercise behavior characteristics, such as converting continuous heart rate data into the proportion of effective exercise time, converting motion capture data into the technical movement compliance rate, and converting exercise record data into weekly exercise frequency and an exercise persistence index. At the second layer, exercise behavior characteristics are linked to specific course objectives. For example, the proportion of effective exercise time corresponds to the objective of exercise participation, the technical movement compliance rate corresponds to the objective of motor skill, and the exercise persistence index corresponds to the objective of health behavior. At the third layer, multiple behavioral indicators are synthesized into assessment judgments at the literacy dimension, forming an overall

description of students' exercise literacy development [5]. This transformation process requires collaborative participation by physical education teachers and assessment researchers to ensure that indicator design is both data-supported and consistent with the internal logic of physical education teaching. Research on the reform of the physical education evaluation system in colleges and universities from the perspective of Healthy China has pointed out that the transformation of physical education assessment indicators should closely follow the educational orientation and avoid falling into a technocratic tendency of data for data's sake [7]. Indicator transformation should also attend to individual differences. For students with a weak exercise foundation, improvement-margin indicators are more educationally meaningful than standards-based indicators. For students with stronger exercise ability, more challenging indicators should be set so that every student can find room for growth in assessment.

3.3 Weight Allocation Layer: Construction of the Process-Oriented Assessment Indicator System

Weight allocation is a key decision-making link in exercise data-driven reform of process-oriented assessment and directly concerns the rationality of assessment orientation and the credibility of assessment results. Based on existing practical schemes, this study proposes the following process-oriented assessment indicator framework [8]:

Table 1 Indicator System for Process-Oriented Assessment in College Public Physical Education Courses Driven by Exercise Data

Primary indicator	Secondary indicator	Assessment content	Data source	Suggested weight
Exercise load	Effective exercise time in class	Cumulative time with heart rate in the effective range (120–180 beats/min)	Wearable devices/smart playground	10%
	Exercise intensity compliance rate	Proportion of class time at moderate or higher intensity	Heart rate monitoring data	5%
Skill improvement	Technical movement compliance rate	Movement standardness assessed according to project technical standards	Motion capture/AI scoring	10%
	Skill improvement margin	Longitudinal change in skill test scores within the semester	Stage test data	10%
Exercise behavior	Extracurricular exercise frequency	Number of effective weekly exercise sessions (≥30 min/session)	Campus running app/check-in system	8%
	Extracurricular exercise persistence	Balance of weekly distribution of exercise behavior within the semester	Time series of exercise records	4%
Learning participation	Class attendance	Actual attendance/required attendance	Academic affairs attendance system	5%
	Classroom activity participation	Records of group practice, competition participation, peer coaching, etc.	Teacher observation + system records	5%
	Physical health improvement	Annual change in physical fitness test scores (improvement margin)	Physical fitness test data	8%
Total process-oriented assessment				65%
Summative assessment	Final skill test	Standardized test of sport-specific skills	Unified test	35%

The above framework follows three principles. First, the weight of process-oriented assessment exceeds half of the total grade, fundamentally changing the traditional structure in which one examination determines the grade and reflecting the due position of process-oriented assessment in physical education courses [8]. Second, each indicator has a clear data source and assessment content, avoiding ambiguous operations in regular scores, so that teachers have evidence for scoring and students have evidence for appeals. Third, improvement-margin indicators, including skill improvement margin and physical health improvement, reflect process-oriented assessment's attention to individual growth, which is more educationally meaningful than purely standards-based assessment. Research by Qiao et al. has shown that incorporating physical health improvement into the process-oriented assessment system can effectively stimulate the exercise enthusiasm of students with a weak exercise foundation and promote the healthy development of all students. Zhang's practice has also demonstrated that a clear process-oriented assessment indicator system and weight structure are key factors for the success of assessment reform [2].

3.4 Feedback Loop Layer: Operation of the Data-Driven Teaching Improvement Mechanism

The value of exercise data lies not only in the assessment link but also in its feedback function. Data-driven process-oriented assessment should form a loop of collection—analysis—feedback—adjustment: teachers adjust teaching rhythm and practice density based on classroom exercise load data; students understand their weak areas through personal exercise reports and formulate improvement plans; teaching administrators optimize course design based on data trends at the class and grade levels. A feedback mechanism based on physical health monitoring data can help teachers accurately identify students' exercise weaknesses and implement targeted teaching interventions, with the experimental group showing significantly better physical health improvement than the control group [4]. The effective operation of the feedback loop transforms process-oriented assessment from terminal judgment into accompanying facilitation. Specifically, the feedback mechanism should include three levels. Immediate feedback displays exercise data in real time through large screens or mobile terminals during class, helping students adjust their exercise state immediately. Stage feedback generates personal exercise reports every four weeks, presenting the completion and progress trends of each indicator. Semester feedback synthesizes full-process data into a student exercise literacy development report, providing suggestions for the next stage of learning. The core value of big data technology lies in integrating scattered exercise data into meaningful teaching information, providing a basis for teachers' teaching decisions and students' autonomous learning. The establishment of the feedback loop allows exercise data to truly integrate into the entire process of physical education teaching and realizes the organic unity of assessment and teaching.

4. Key Issues in Implementation and Countermeasures

4.1 Equipment Coverage and Assessment Equity

The primary constraint on exercise data-driven reform of process-oriented assessment is the tension between sufficient equipment coverage and assessment equity. The deployment cost of smart playgrounds and wearable devices is relatively high, which in the short term may create prerequisite differences across campuses and projects. If key universities have already built complete smart sports systems while ordinary universities still rely on manual records, assessment standards across institutions will be difficult to unify, and the educational value of exercise data will be constrained by the differentiation of technical conditions. In this regard, tiered implementation is a more pragmatic strategy. Priority should be given to deploying equipment in compulsory public physical education courses and projects with broad coverage to maximize the number of benefiting students. For campuses or projects with limited conditions, low-cost methods such as campus running apps can first be used to collect extracurricular exercise data, gradually transitioning to an integrated data collection system covering both inside and outside class.

Students should also be allowed to use their own devices as a supplement, but unified data interface standards must be established to ensure that data from different sources can be incorporated into the same assessment system. Xu's research has shown that even under limited equipment conditions, assessment reform based on physical health monitoring data can still achieve significant results; the key lies in the match between the data collection scheme and teaching realities [4]. Assessment equity also involves another dimension: students with a weak exercise foundation may be disadvantaged in data due to unfamiliarity with devices or insufficient exercise ability, and indicator design should balance this through improvement-margin indicators.

4.2 Data Ethics and Privacy Protection

Exercise data involve students' physiological information and behavioral trajectories, and their collection, storage, and use must be brought under clear ethical norms. Heart rate data can reflect students' health status, and exercise trajectories can reveal students' activity patterns. If such information is used improperly, it may infringe on students' privacy rights. Xie pointed out in research on optimization strategies for the evaluation system of primary and secondary school physical education teaching that data collection supported by artificial intelligence technology should follow the principle of being necessary and appropriate, avoiding privacy risks and student resistance caused by excessive collection [6]. Specifically, data ethics norms should cover three levels. At the collection level, the principle of informed consent should be followed, explaining to students the purpose, scope, and retention period of data and allowing students to query and correct their personal data. At the use level, it should be clarified that data are used only for teaching assessment and teaching improvement and not for other commercial purposes or unauthorized academic research. At the storage level, a tiered authorization mechanism should be established, whereby teachers can access only student data from the classes they teach, and teaching administrators can view only de-identified aggregate data. Research has emphasized that the application of big data technology in physical education teaching evaluation requires a supporting data security management system; technical convenience must not come at the expense of student rights [3]. Only by operating within an ethical framework can exercise data-driven assessment reform gain students' trust and cooperation, and can its educational value be truly realized.

4.3 Teachers' Data Literacy and Capacity Building

The scientification of process-oriented assessment places new capacity demands on physical education teachers. Traditional teaching ability is mainly reflected in motor skill demonstration and classroom organization and management, whereas the data-driven assessment model requires teachers to possess the ability to interpret exercise data and make teaching decisions based on data. Specifically, teachers need to understand the meanings of data indicators such as heart rate intervals, exercise density, and the exercise persistence index, identify students' exercise problems and progress trends from data, and adjust teaching strategies accordingly. Research has shown that the effectiveness of big data in physical education teaching evaluation depends to a large extent on teachers' data literacy; teachers lacking data interpretation ability cannot transform data advantages into teaching advantages [3]. In current pre-service education and in-service training for physical education, content on exercise data analysis and application has not yet been systematically incorporated, which constitutes a practical bottleneck for reform. Countermeasures include adding modules on exercise data interpretation and teaching application to teacher training, using case-based teaching to help teachers master the transformation from data to decision-making; establishing school-based professional development mechanisms for teacher data literacy and encouraging teachers to exchange experience in data application based on their own teaching practice; and, in the early stage of assessment reform, providing data teaching assistants or technical support personnel to assist teachers with data analysis and lower the technical threshold. Research has confirmed that, with support from learning analytics technology, trained teachers can effectively use assessment data to improve teaching, and their experimental classes show significantly better

teaching effects than control classes [5].

4.4 Assessment Boundaries and the Datafication Trap

Exercise data-driven assessment reform must guard against the datafication trap—that is, overreliance on quantitative data while neglecting educational outcomes in physical education that are difficult to quantify. Learning outcomes in dimensions such as sports character, cooperative spirit, volitional quality, and rule awareness are important for students' all-round development but cannot be fully reflected through heart rate, step frequency, or movement scores. Research on the reform of the physical education evaluation system in colleges and universities from the perspective of Healthy China has emphasized that reform should adhere to the combination of quantitative and qualitative assessment and avoid reducing complex educational processes to cold data [7]. Exercise data should serve as an enhancement tool for process-oriented assessment rather than a replacement. In the indicator system, quantifiable dimensions such as exercise load, skill improvement, and exercise behavior can achieve precise assessment through data-driven methods, whereas behaviors in the learning participation dimension, such as classroom activity participation and peer coaching, still require supplementary teacher observation records and qualitative judgment. Even within quantifiable dimensions, the interpretive boundaries of data should be noted: an abnormal heart rate reading may result from device error rather than a real change in a student's exercise state, and motion capture scoring may fail to accurately identify certain technical details due to algorithmic limitations. Therefore, data-driven process-oriented assessment should establish a dual assessment mechanism of data plus judgment, in which data provide an objective foundation and teachers make final judgments based on professional experience.

5. Conclusion

Exercise data-driven reform of process-oriented assessment in college public physical education courses is essentially a shift in assessment logic: from reliance on teachers' experiential judgment to systematic analysis based on exercise behavior data, from one-time outcome evaluation to dynamic tracking of the whole process, and from standards-based assessment to growth-oriented assessment. The four-stage driving model of data collection—indicator transformation—weight allocation—feedback loop, and the assessment indicator system covering exercise load, skill improvement, exercise behavior, and learning participation, provide an operable technical pathway for this reform. Zhang's practical exploration in higher vocational colleges, Xu's experimental research based on physical health monitoring data, and Yan et al.'s experimental study of an evaluation system supported by learning analytics all confirm, from different perspectives, the feasibility and effectiveness of data-driven assessment reform. It must be clearly recognized, however, that data are a means rather than an end, and the ultimate goal of process-oriented assessment reform is to promote the authentic development of students' exercise literacy. Future research should further examine the causal mechanisms between exercise data and teaching interventions, as well as differences in the applicability of data-driven assessment across different sports projects and student groups, so as to provide more solid theoretical support and practical guidance for assessment reform in college public physical education courses.

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