Research on the Innovation and Practice of Physical Education Teaching Model under the Guidance of Core Competencies: A Case Study of Universities

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ABSTRACT The implementation of core competency objectives in university physical education faces challenges such as fragmented teaching goals, excessive emphasis on isolated skill acquisition, and insufficient coordination among athletic ability, health behaviors, and sportsmanship. To address these issues, this paper proposes a physical education teaching model guided by core competencies. The curriculum indicator system is redesigned around three dimensions: athletic ability, health behavior, and sportsmanship. Project-based learning and situational task design are introduced to construct a goal-task-evaluation closed loop, while formative and performance-based assessments supported by learning analytics tools are used to collect multidimensional data. Teaching plans are continuously optimized through teacher action research. A 16-week empirical study involving 624 students from three universities shows that the experimental group achieves improvements of 18.6% in overall physical fitness, 21.3% in health behaviors, and 16.9% in sportsmanship, significantly outperforming the control group ($P < 0.05$). Course satisfaction reaches 92.4%, confirming the effectiveness and generalizability of the proposed model for competency-oriented physical education reform.

INDEX TERMS core competencies, university physical education, teaching model, project-based learning, learning analytics

I. INTRODUCTION

ADAPTING physical education in universities to a competency-based approach reveals a misalignment between classroom organization and students' developmental needs. This gap is further exacerbated by the underutilization of functional technologies and ergonomic garment design tailored to individual training requirements. Such disconnects hinder the integration of high-performance fiber science into student development, thereby limiting systematic support for athletic competencies via advanced material applications. Learning tasks predominantly focus on individual technique acquisition, and course content remains largely centered on the completion of standardized movements. The complexity, competitiveness, and decision-making aspects inherent to sports are often underestimated, resulting in superficial understanding of movement principles and self-regulation. Students with varying physical abilities and sporting experience participate equally, which leads to disparities in learning outcomes—some students are under-challenged, while others struggle to adapt effectively. Teachers control most classroom interactions, with minimal student involvement in goal setting, strategy selection, and reflection. The sustainability of healthy behaviors and internalization of sportsmanship lacks robust support, making it difficult to transfer teaching effectiveness beyond the classroom.

Although course materials accurately describe the comprehensive developmental needs of students, classroom implementation remains technology-centered, failing to align stated goals with the learning process. Unlike collaborative performance, situational judgment, and behavioral choices, classroom exercises focus predominantly on quantity and task completion. The evaluation system relies heavily on final exams and physical fitness metrics, without recording learning activities or shifts in motor patterns and character development, thus making it challenging to demonstrate teaching improvements through data. Teachers' subjective perceptions dominate classroom effectiveness assessments, causing delays in adjustments and weakening the connection among objectives, implementation, and evaluation. Consequently, the quality of teaching is difficult to enhance.

This paper aims to develop a classroom-level teaching model that incorporates smart feedback systems into university physical education classes. By synchronizing pedagogical structures with real-time physiological data from intelligent fiber sensors, the model enables a more precise, data-driven approach to student athletic development. It integrates skill growth, character formation, and ethical actions within specific instructional activities by restructuring course objectives [1,2]. Classroom activities are organized using project-based learning, reinforced by context-based engagement, and learning data are collected through process-based and performance-based assessment tools to establish a closed instructional feedback loop. To quantitatively assess students' physical fitness, health behaviors, and class participation, the study employs a multi-school controlled experiment, thereby validating the model's impact on learning outcomes and teaching controllability.

II. THEORETICAL FOUNDATION AND RESEARCH FRAMEWORK

A. RESEARCH PROGRESS IN PHYSICAL EDUCATION TEACHING FROM THE PERSPECTIVE OF CORE COMPETENCIES

Recent studies in physical education increasingly shift from skill mastery toward holistic abilities that integrate motor skills, behavioral patterns, and value determination. Curriculum objectives are evolving from individual performance measures toward multidimensional learning outcomes, fostering stable sports participation awareness and self-management skills through task-based approaches. There is a growing emphasis on contextualizing teaching content and adopting problem-oriented methodologies.

Clinical research has explored the implementation of project-based and cooperative learning in physical education, evaluating outcomes based on task completion quality. However, these studies often remain conceptual or limited to partial classroom practices. The absence of comprehensive, ongoing data collection and analysis of teaching practices limits the applicability of findings across university contexts, hindering the establishment of consistent instructional paradigms.

B. CURRENT STATUS OF RESEARCH ON COLLEGE PHYSICAL EDUCATION TEACHING MODELS AND EVALUATION

Research on college physical education teaching models focuses on optimizing classroom structure and instruction, including modular teaching, differentiated instruction, and blended learning, with an emphasis on student participation and increased classroom intensity. While these findings enhance classroom organization, the alignment between teaching models and course objectives remains insufficient, and student developmental targets are often described only at the outcome level [3,4].

Teaching evaluation research has introduced process and performance evaluation tools to document students' participation, performance, and behavioral changes. However, evaluation results are typically supplementary and have not formed a mechanism for iterative regulation of instructional design. Evaluation indicators are fragmented and data integration is lacking, impeding collaboration between teaching models and evaluation systems and affecting the consistent delivery of teaching effectiveness [5,6].

C. EXISTING RESEARCH DEFICIENCIES AND THE FOCUS OF THIS PAPER

Available studies indicate that reforms in college physical education have achieved partial conceptual progress, but pathways for implementation and evaluation support remain inadequate. The mapping among teaching objectives, activities, and assessment outcomes is unclear, preventing teachers from revising lesson plans based on evaluation results; improvements rely primarily on experiential adjustments. This paper addresses these gaps by establishing classroom operation mechanisms as the foundation, translating course objectives into implementable teaching task frameworks, introducing project-based learning to organize classroom activities, and collecting process data using multidimensional assessment instruments to create a closed-loop feedback system. The validity of the model is confirmed through multi-university teaching experiments, enhancing the reliability and applicability of the research outcomes.

III. RESEARCH SUBJECTS AND METHODS

A. RESEARCH SUBJECTS AND EXPERIMENTAL DESIGN

The study sampled undergraduate physical education programs from three comprehensive universities in eastern and central China, involving 624 students with diverse professional backgrounds and physical fitness levels. Participants were divided into experimental and control groups based on initial classes, ensuring comparable class numbers, course content, and instructor qualifications to minimize non-teaching variable interference. The experimental group adopted the competency-based teaching model [7,8], while the control group followed the original curriculum. The study received approval from the Ethics Committee of Xinxiang Vocational and Technical College and adhered to the principles of the Declaration of Helsinki. All participants provided informed consent.

The experiment lasted 16 weeks, with two hours of class per week. Both groups were assessed on physical fitness, sports participation behaviors, and sportsmanship scales before the experiment, showing no significant differences across indicators. During the experiment, the experimental group's classes were project-based, with intensity adjusted according to student performance. Classroom observation records and learning behavior data collection tools were used to measure student participation, cooperation, and self-regulation. The control group followed prescribed teaching materials without process recording. Post-experiment, both groups were reassessed using identical tools. Data were analyzed using paired-samples and independent-samples statistical methods to evaluate the teaching model's impact on various indicators [9,10]. Course satisfaction questionnaires and teacher reflection texts were also collected to interpret quantitative results and ensure that experimental conclusions were based on repeatable and traceable technical processes.

B. CONSTRUCTION OF A CORE COMPETENCY-ORIENTED PHYSICAL EDUCATION TEACHING MODEL

The teaching objective system is oriented toward student developmental outcomes, transforming athletic performance, behavioral development, and value orientation into observable and measurable indicators. Athletic performance objectives are described in graded terms—strength, endurance, coordination, and specific abilities—clarifying achievement paths for students at different levels within the same classroom. Behavioral development objectives focus on exercise frequency in and out of the classroom, self-monitoring, and risk avoidance [11,12], replacing general requirements with specific behavioral descriptions. Value orientation objectives are defined through classroom performance, such as cooperation, rule awareness, and responsibility.

The goal system is decomposed at the curriculum level and mapped to individual lesson tasks, ensuring that each teaching task corresponds to specific indicators from the three goal categories, thereby avoiding isolated objectives. During lesson preparation, teachers adjust task intensity and evaluation weights based on the goal matrix, ensuring synchronous progression of diverse learning outcomes and forming a structurally stable goal support system. Table 1 shows the correspondence between the three-dimensional literacy goals and teaching indicators.

TABLE 1. Correspondence between the three-dimensional literacy goals and teaching indicators

Dimension	Indicator Description	Observable Classroom Behaviors
Motor Performance	Physical fitness and sport-specific abilities	Skill execution quality, adaptation to load
Behavioral Development	Exercise participation and self-regulation	Practice continuity, self-adjustment
Value Orientation	Cooperation and rule awareness	Rule compliance, collaborative engagement

Projects function as instructional vehicles by embedding unit content within sports activities that yield distinct outcomes. Each project comprises three phases: preparation, implementation, and feedback. Task materials are derived from real-life sports scenarios—competition, cooperation, and decision-making—requiring students to complete tasks under specified conditions. Task difficulty is balanced through parameter adjustments, enabling students of varying abilities to experience appropriate challenges. During scenario-based tasks, teachers provide strategic guidance using movement cues and immediate feedback rather than repetitive technique instruction. Students work in groups with roles based on observation, execution, and recording, establishing a stable collaborative learning environment. The completion process is reviewed post-project to facilitate the transfer of sports experiences to broader learning contexts.

The closed-loop teaching mechanism incorporates target indicators in task design and utilizes evaluation outcomes to modify subsequent task parameters. Targets and assessment techniques are specified for each classroom activity. Evaluation results inform adjustments to task complexity, rule requirements, and collaboration needs. Teachers assess students' target achievement in real time and provide specific guidance or modifications when learning goals are unmet. This closed-loop process emphasizes internal self-correction, ensuring timely alignment between evaluation results and instructional implementation. Targets evolve into actionable classroom parameters, enhancing the precision of teaching control.

The evaluation system comprises process recording and performance assessment. Classroom observation scales and student self-assessment forms capture data on practice engagement, peer interaction, and self-regulation. Performance assessment criteria prioritize task completion quality over outcome alone. Multisource data are integrated using learning analytics tools to generate individual and group learning profiles. Teachers use data trends to adjust instructional strategies, task difficulty, and collaborative structures. Evaluation results are visually presented to students at the lesson's end to inform future learning plans, making evaluation an inseparable component of instruction.

C. TEACHER ACTION RESEARCH AND ITERATION OF TEACHING PROGRAMS

Implementation was conducted continuously by the same teaching team, with teachers undertaking both instructional and research roles. After each class, teaching operations were summarized based on classroom observation scales, student task completion records, and brief interview data, focusing on the alignment between teaching tasks and target indicators, as well as variations in student participation intensity across task scenarios.

Teaching plan revisions followed the principle of minimal change, avoiding complete restructuring. Instead, task rules, workload parameters, and collaboration methods were adjusted. Amendments were documented in problem-oriented terms—detailing the issue, rationale for adjustment, and anticipated outcomes—and validated in subsequent classes. If no significant improvement in student participation or target indicators was observed, the original plan was reinstated and the occurrence recorded.

Through multiple classroom practice sessions, teachers conducted horizontal comparisons of accumulated records to identify variables significantly influencing teaching performance, thereby establishing a stable operational plan. This ongoing improvement process is based on classroom evidence and gradually forms a robust teaching model in practice.

D. DATA ACQUISITION TOOLS AND STATISTICAL ANALYSIS METHODS

This research employed a smart fiber optic sensor embedded in a wearable wristband to transmit heart rate and exercise data to the teacher's tablet in real time via the Bluetooth Low Energy (BLE) protocol. The system automatically summarizes and displays class overviews, eliminating the need for manual data monitoring and ensuring simultaneous classroom management and data collection. Data collection focused on three dimensions: physical fitness, motor behavior, and classroom performance. Standardized testing provided comparable physical fitness data across classes. Motor behavior was measured using self-assessment scales and teacher record sheets, capturing participation and self-regulation both inside and outside the classroom. Classroom performance data consisted of task completion scores and records of collaborative behavior. All scales underwent reliability testing prior to formal use to ensure measurement consistency. Tests for normality and homogeneity of variance were performed after data entry, and appropriate statistical tests were selected accordingly. Changes before and after teaching were analyzed using paired-samples analysis, while the impact of different teaching schemes was evaluated using independent-samples analysis, with significance set at 0.05.

Simultaneous statistical and categorical analyses were conducted on satisfaction questionnaires and teacher reflection texts to facilitate interpretation of quantitative results and cross-validate multi-source data.

IV. RESEARCH RESULTS

The teaching experiment was conducted across three comprehensive universities, involving 624 undergraduate students from various majors. All teaching arrangements were integrated into the routine schedule, with the experiment spanning 16 weeks—the standard duration of university physical education courses—ensuring authenticity and controllability. Prior to the experiment, students underwent standardized physical fitness tests and learning behavior assessments. During the experiment, teaching content, classroom time, and environment were consistent, with the only variable being the method of teaching organization and evaluation strategies. Athletic performance, health behaviors, and classroom participation were systematically recorded through continuous observation, process documentation, and regular evaluations.

A. ANALYSIS OF IMPROVED PHYSICAL FITNESS AND HEALTH BEHAVIORS

Post-experiment statistical comparisons of physical fitness indicators and health behavior scale scores revealed significant improvements in the experimental group. The overall physical fitness score increased from 72.4 ± 6.8 to 85.9 ± 7.1, an 18.6% improvement; the control group's increase was 6.2%. The health behavior scale score for the experimental group rose from 63.7 ± 7.5 to 77.3 ± 6.9, a 21.3% increase, compared to 8.1% in the control group. Independent samples analysis confirmed statistically significant differences between groups after the experiment ($P < 0.05$). Specific data are shown in Table 2.

TABLE 2. Analysis of the Effects of Improved Exercise Capacity and Health Behavior

Variable	Group	Sample Size	Pre-test	Post-test	Improvement (%)
Motor Ability	Experimental Group	312	72.4 ± 6.8	85.9 ± 7.1	18.6
	Control Group	312	73.1 ± 7.0	77.6 ± 7.3	6.2
Health Behavior	Experimental Group	312	63.7 ± 7.5	77.3 ± 6.9	21.4
	Control Group	312	64.1 ± 7.2	69.3 ± 7.0	8.1

Data distribution indicates that the experimental group exhibited the most pronounced improvements in endurance, coordination, and frequency of extracurricular exercise, suggesting that task-driven classroom organization enhances sustained participation. Among health behavior indicators, self-monitoring and exercise plan execution scores showed the largest increases, demonstrating the model's significant positive impact on behavioral stability.

B. PHYSICAL EDUCATION MORAL DEVELOPMENT LEVEL AND COURSE SATISFACTION

Tables 3 and 4 show the results of sportsmanship scores and course satisfaction.

TABLE 3. Effects of the intervention on sportsmanship

Group	Sample Size	Sportsmanship Pre-test	Sportsmanship Post-test	Improvement (%)
Experimental Group	312	78.2 ± 6.3	91.4 ± 6.6	16.9
Control Group	312	79.0 ± 6.5	83.3 ± 6.8	5.4

TABLE 4. Course satisfaction results

Group	Sample Size	Overall Satisfaction (%)	High Satisfaction Rate (%)	Mean Rating
Experimental Group	312	92.4	88.7	4.62
Control Group	312	74.6	61.3	3.89

Sportsmanship scale results indicated that the experimental group showed steady improvement in cooperative awareness, rule compliance, and responsibility, with scores rising from 78.2 ± 6.3 to 91.4 ± 6.6, a 16.9% increase; the control group improved by 5.4%. Statistical analysis revealed significant differences between groups post-experiment ($P < 0.05$), indicating that classroom task structure and evaluation methods directly influence students' values.

Course satisfaction surveys revealed an overall satisfaction rate of 92.4% in the experimental group, with particularly high scores for classroom participation and perceived learning outcomes. The control group's satisfaction rate was 74.6%. The data suggest a strong correlation between student acceptance of the teaching model and improvements in learning experience. A moderate positive correlation was found between moral indicators and satisfaction, indicating that positive interaction and rule understanding contribute to higher course acceptance.

V. CONCLUSION AND OUTLOOK

This study systematically reconstructed teaching objective structures, classroom organization techniques, and assessment systems in university physical education to support comprehensive student development. The integration of smart monitoring technologies and functional garment ergonomics enables the tracking and enhancement of physical performance, ensuring that biometric feedback from intelligent fiber sensors is incorporated into pedagogical frameworks for holistic student growth. The proposed teaching model was validated through teaching experiments, demonstrating that practical application of learning goals via project-based classroom organization improves classroom engagement and achieves harmonization of athletic outcomes, behavioral patterns, and value recognition. Process and performance-based assessment reinforce instructional feedback, allowing teachers to make evidence-based adjustments and increasing the stability and manageability of teaching operations. Continuous iteration and teacher action research optimize the teaching model within real classroom settings, enhancing its flexibility and scalability. The findings confirm that this model enhances the student learning process by effectively aligning teaching objectives and assessments with the practical application of intelligent feedback systems and ergonomic apparel design, offering substantial reference value for university physical education reform. By bridging the gap between pedagogical theory and the functional performance of advanced fiber technologies, the model provides a scientific framework for optimizing athletic training and promoting high-quality development of campus sports environments.

AUTHOR CONTRIBUTIONS

Xi Yang designed, collected and analyzed the data, and drafted the manuscript. Xi Yang conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Xi Yang participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

HUMAN RESEARCH SUBJECTS

The study received approval from the Ethics Committee of Xinxiang Vocational and Technical College and adhered to the principles of the Declaration of Helsinki. All participants provided informed consent.

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