

Theoretical Framework and Pedagogical Implementation of the SPOC-Based Instructional Model in Collegiate Volleyball General Education

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Keywords: SPOC teaching model; general volleyball course; digital teaching; physical education reform

Abstract: Against the backdrop of educational digitalization, university physical education courses urgently require innovative instructional models to enhance teaching effectiveness and foster students' lifelong physical literacy. Volleyball general courses, characterized by high skill complexity and strong requirements for team coordination, face practical challenges such as limited class hours, significant disparities in student proficiency levels, and diversified evaluation dimensions. This study aims to explore the theoretical underpinnings and practical value of applying the SPOC (Small Private Online Course) instructional model in volleyball general courses. Drawing on theories from pedagogy, psychology, and sports didactics, the study adopts an approach integrating literature review, theoretical construction, and case-based validation to systematically delineate the core features of the SPOC model and to construct a three-dimensional theoretical framework for its application in volleyball instruction. The findings indicate that building a self-organized learning system integrating in-class and out-of-class contexts can effectively overcome the inherent limitations of traditional volleyball teaching. This study not only enriches the theoretical discourse on the digital transformation of physical education, but also provides practical guidance for the reform of university sports curricula.

1. Introduction

In recent years, the Chinese government has continuously strengthened top-level policy design and strategic guidance by issuing a series of programmatic documents, including the National Strategy for Education Digitalization, thereby positioning educational digitalization as a major driving force for educational transformation and the realization of personalized and lifelong learning. According to statistics released by the Ministry of Education, from 2021 to 2024, the number of online courses offered by Chinese universities increased by more than 35%, while the coverage of blended learning continued to expand [1]. Against this backdrop, the rapid advancement of digital transformation in higher education has accelerated the implementation of blended online–offline teaching models. Consequently, university physical education courses are

under increasing pressure to leverage digital technologies to enhance teaching quality and cultivate students' lifelong physical literacy—that is, the comprehensive ability to engage independently in physical exercise and maintain healthy lifestyles after graduation. Within the process of educational digitalization, the Small Private Online Course (SPOC), a blended teaching model integrating the strengths of online learning and traditional face-to-face instruction, has developed rapidly in the post-MOOC era. By limiting enrollment, strengthening teacher–student interaction, integrating structured learning resources, and providing precise learning analytics and feedback, SPOC facilitates the deep integration of online and offline teaching and has become an important practical form of educational digitalization [2]. Compared with Massive Open Online Courses (MOOCs), SPOC places greater emphasis on personalized learning support and continuous monitoring of the learning process, thereby improving teaching efficiency and learning outcomes under limited classroom hours. In recent years, studies have explored the application of SPOC in university table tennis courses and general physical education courses, demonstrating its effectiveness in enhancing students' autonomous learning abilities and skill acquisition. However, existing research has mainly focused on short-term effectiveness evaluations and case studies, while systematic theoretical explanations and cross-course comparative analyses remain insufficient, limiting the broader application and further development of SPOC in physical education [3]. As a compulsory course for physical education majors, the volleyball general course is characterized by highly structured skill acquisition, complex motor techniques, and strong requirements for teamwork and cooperation. Meanwhile, it faces practical challenges such as limited instructional hours, substantial differences in students' prior skill levels, and multidimensional assessment requirements [4]. These characteristics make it an ideal context for evaluating the effectiveness of the SPOC teaching model. On the one hand, mechanisms embedded in SPOC—including hierarchical resource delivery, microlearning videos and virtual simulations, real-time feedback, and personalized diagnostic support—can effectively address the major instructional challenges of volleyball teaching. On the other hand, the high demands for collaborative learning and refined technical instruction in volleyball provide a representative setting for examining the pedagogical adaptability of SPOC. Against this background, this study takes the volleyball general course as its research context to systematically examine the core characteristics of the SPOC teaching model, analyze its pedagogical compatibility with volleyball instruction, and construct a multidimensional theoretical framework and practical implementation pathway based on perspectives from educational theory, psychology, and physical education pedagogy. The study aims, first, to reveal the theoretical foundations underlying the effectiveness of the SPOC model by exploring its alignment with cognitive mechanisms, instructional design principles, and skill acquisition processes, thereby addressing the theoretical question of why the model is effective. Second, it proposes practical solutions, including integrated online–offline teaching and a self-organized learning system, to explore how SPOC can be effectively implemented in volleyball instruction. The findings are expected not only to provide theoretical support and practical guidance for the reform of university volleyball general courses but also to offer a transferable and scalable model for the digital transformation of other physical education courses.

2. Characteristics of the SPOC Teaching Model and the Features of the Volleyball General Course

2.1 Core Characteristics and Advantages of the SPOC Teaching Model

With the continuous advancement of educational digitalization and the widespread adoption of blended learning, the Small Private Online Course (SPOC), as an important innovation in the post-MOOC era, has demonstrated significant advantages in higher education—particularly in

skill-oriented physical education courses—through its characteristics of small-scale enrollment, restricted access, and intensive interaction. The core features of the SPOC teaching model can be summarized into four aspects. First, it provides a structured online learning environment, in which modular instructional design and integrated microlearning resources enable the systematic organization and presentation of knowledge. Second, it incorporates a precision-oriented interaction mechanism, utilizing intelligent grouping and real-time feedback systems to facilitate personalized instruction and effective teacher–student interaction. Third, it establishes a data-driven feedback and assessment mechanism, employing learning behavior analytics and predictive models to transform instructional decision-making from experience-based judgment to evidence-based practice. Fourth, it adopts a flipped classroom reconstruction mechanism, restructuring the instructional process through a “online knowledge acquisition–offline knowledge internalization” sequence, thereby optimizing classroom time allocation, enhancing students' learning initiative, and promoting deeper skill internalization [5]. These characteristics indicate that the SPOC teaching model not only shifts instructional objectives from knowledge transmission toward competency-oriented learning but also overcomes the traditional one-to-many interaction pattern through enhanced communication mechanisms. Furthermore, it advances data utilization from macro-level statistical analysis to micro-level learning diagnosis and integrates deeply into institution-specific curricula. Such advantages enable SPOC to address the contextual challenges associated with the automatic acquisition of volleyball skills. Consequently, the SPOC teaching model provides systematic support for skill internalization in university volleyball general courses and demonstrates sustainable structural advantages in the digital transformation of physical education [6].

2.2 The Pedagogical Compatibility of the SPOC Teaching Model with the Volleyball General Course

The volleyball general course is characterized by complex motor skills, strong requirements for teamwork, substantial differences in students' skill levels, and limited instructional hours. Traditional teaching methods often encounter problems such as inadequate demonstration of technical movements, abstract tactical instruction, and difficulty in accommodating individual learning differences [7]. The structured learning resources, differentiated content delivery, and integrated online–offline learning environment provided by the SPOC teaching model closely correspond to these instructional challenges. In the context of volleyball instruction, the pedagogical value of SPOC is primarily reflected in three aspects. First, the complexity of volleyball techniques aligns well with the structured learning resources offered by SPOC. Volleyball techniques involve intricate movement patterns and are easily affected by viewing angles, making it difficult for students to observe technical details through conventional classroom demonstrations. By providing diversified learning resources—including segmented movement demonstrations, multi-angle video presentations, and virtual simulation scenarios—SPOC enables students to develop stable and repeatable technical representations before class, thereby establishing a solid cognitive foundation for subsequent skill practice. Second, individual differences among students correspond well to SPOC's differentiated content delivery mechanism. Students enrolled in volleyball general courses often possess diverse skill levels, while limited classroom time restricts teachers' ability to meet individual learning needs through traditional one-size-fits-all instruction. Based on learning analytics, the SPOC platform can provide personalized resource recommendations, adaptive grouping, and individualized diagnostic feedback, thereby supporting differentiated instruction that matches the diverse learning needs of volleyball students. Third, the process of motor skill acquisition is highly compatible with SPOC's integrated online–offline learning mechanism. The internalization of volleyball skills requires repeated practice and continuous reinforcement beyond

classroom instruction, yet traditional teaching often lacks effective follow-up and monitoring. Through online learning tasks, movement evaluation, and learning trajectory tracking, SPOC establishes a comprehensive instructional process encompassing pre-class cognitive preparation, in-class skill practice, and post-class consolidation, which conforms to the developmental progression of motor learning from cognitive understanding to autonomous skill execution.

3. Theoretical Foundations and Operational Mechanism of Applying the SPOC Teaching Model to the Volleyball General Course

3.1 A Three-Dimensional Theoretical Foundation for Applying the SPOC Teaching Model to the Volleyball General Course

As illustrated in Figure 1, the Three-Dimensional Theoretical Foundation Model depicts the theoretical support system and the underlying logical relationships of the SPOC teaching model in the volleyball general course. Learning in volleyball involves highly structured processes of skill acquisition, tactical understanding, and teamwork, which require a solid theoretical foundation grounded in cognitive science, instructional design theory, and motor learning theory. The three dimensions of the model correspond respectively to the cognitive process of learning, the instructional organization process, and the motor skill acquisition process, collectively forming the theoretical basis for integrating the SPOC teaching model into the volleyball general course.

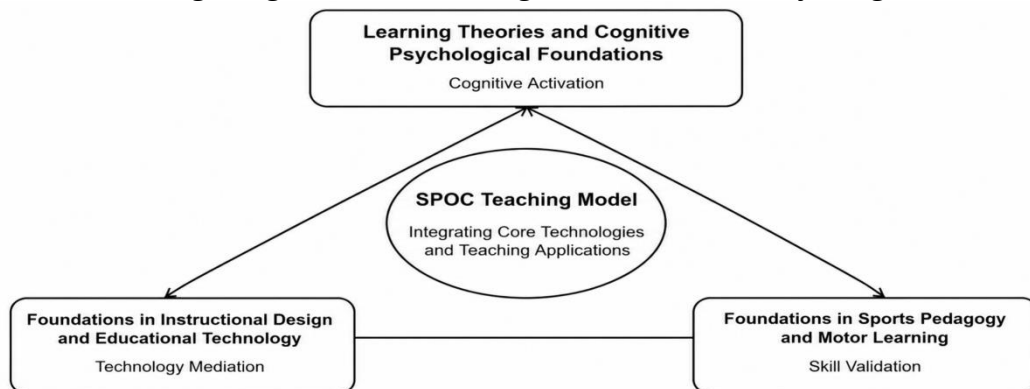


Figure 1. A Three-Dimensional Theoretical Foundation Model for Applying the SPOC Teaching Model to the Volleyball General Course

3.1.1 Foundations in Learning Theory and Cognitive Psychology

Against the backdrop of modern educational technology, the integration of the SPOC teaching model into volleyball instruction enables the synthesis of four major theoretical perspectives: constructivism, cognitive load theory, information processing theory, and social learning theory. First, constructivism argues that knowledge is actively constructed by learners on the basis of their prior experiences rather than passively transmitted by instructors [8]. In the SPOC-based volleyball course, multimodal learning resources dynamically decompose tactical concepts. For example, online animated demonstrations of the 4–2 offensive system allow students to integrate new information with their existing knowledge and construct tactical understanding independently. Pre-class learning activities further facilitate the development of cognitive schemas, addressing the limitations of traditional instruction, such as abstract tactical explanations and insufficient student engagement [9]. Second, cognitive load theory maintains that the capacity of working memory is limited; therefore, instructional design should minimize cognitive overload. The SPOC platform addresses this by dividing complex volleyball techniques into manageable learning units. For

instance, the serving technique is segmented into three stages—ball toss, arm swing, and ball contact—with each microlearning video limited to approximately 90 seconds, thereby reducing intrinsic cognitive load. At the same time, irrelevant information is eliminated, while contextual learning tasks, such as analyzing net-touch violation cases, are incorporated to increase germane cognitive load and promote deeper information processing. Third, information processing theory conceptualizes learning as a continuous process involving information encoding, storage, and retrieval. The SPOC platform employs slow-motion replay and multi-angle video recordings to present critical moments of forearm passing and setting, thereby strengthening the encoding of technical details. In addition, daily flashcard exercises on rotational sequences reinforce long-term memory retention, compensating for the limitations of traditional classroom instruction, including restricted observation angles and delayed tactical responses during gameplay. Fourth, social learning theory posits that learning occurs through observing the behaviors and outcomes of others [10]. Accordingly, the SPOC platform provides professional demonstration videos recorded from multiple perspectives, using the attacking techniques of national team players as performance benchmarks. Comparisons between correct and incorrect forearm passing techniques further assist students in identifying and correcting technical errors. In addition, online discussion forums showcase exemplary tactical analyses, encouraging peer observation, interaction, and collaborative learning while alleviating instructional challenges associated with limited demonstration perspectives and difficulties in correcting improper movements.

In summary, the integration of these four theoretical perspectives provides a comprehensive theoretical foundation for the design and implementation of the SPOC-based volleyball course. It facilitates the transition from experience-based instruction to evidence-informed teaching, thereby enhancing students' tactical understanding and mastery of specialized volleyball skills.

3.1.2 Foundations in Instructional Design and Educational Technology

The SPOC teaching model integrates blended learning theory, mastery learning theory, the flipped classroom model, and Merrill's First Principles of Instruction into its instructional design. First, blended learning theory emphasizes the integration of the flexibility of online learning with the interactivity of face-to-face instruction, creating a synergistic effect in which the combined approach is more effective than either mode alone. In volleyball instruction, students acquire knowledge of rules and fundamental concepts through pre-class microlearning videos, engage in tactical transfer through tactical board exercises and game-based practice during class, and optimize their skills through real-time feedback after class. This process promotes students' competency development through a continuous cycle of cognition, practice, and reflection [11]. Second, mastery learning theory advocates a pedagogical sequence of "mastery before progression." With the support of the SPOC platform, instructional content can be delivered according to students' proficiency levels. Students in the introductory group must first pass competency assessments before gaining access to advanced learning resources. Meanwhile, the system automatically recommends customized microlearning materials based on students' learning analytics. For example, students who frequently serve the ball out of bounds may receive a targeted instructional video on ball-contact point control, thereby mitigating the influence of individual learning differences on instructional progress. Third, the flipped classroom model transfers knowledge acquisition to the online environment while reserving classroom time for skill training and tactical cooperation. For example, in serving instruction, students complete theoretical learning before class, allowing classroom activities to focus on an integrated process of technical training, tactical application, and game-based practice. Video replay systems are simultaneously employed to provide step-by-step diagnosis and immediate feedback on spiking techniques, thereby addressing the problem of superficial skill acquisition caused by limited classroom hours. Finally, Merrill's First Principles of

Instruction propose a structured instructional sequence consisting of activating prior knowledge, demonstrating new knowledge, applying new knowledge, and integrating learning into practice [12]. In the context of forearm passing instruction, this process begins by identifying common force-generation problems, followed by slow-motion demonstrations and guided feedback training, and culminates in collaborative group practice and game simulations that facilitate the transformation of conceptual knowledge into practical skills. Taken together, these four instructional theories demonstrate a high degree of complementarity when supported by the SPOC teaching model, collectively enhancing the scientific rigor, instructional hierarchy, and adaptability of university volleyball teaching.

3.1.3 Foundations in Physical Education Pedagogy and Motor Learning Theory

According to the three-stage model of motor skill acquisition proposed by Fitts and Posner—the cognitive stage, associative stage, and autonomous stage [13]—the SPOC teaching model provides targeted instructional support throughout each stage of skill development. During the cognitive stage, learners develop an initial understanding of motor skills primarily through observation and comprehension. The primary instructional objective at this stage is to reduce cognitive load while establishing fundamental movement concepts and technical principles. The SPOC platform supports this process by providing high-definition demonstration videos, detailed explanations of key movement elements, and examples of common technical errors, enabling students to accurately understand the essential characteristics of volleyball skills during the early stages of learning and thereby improving learning efficiency. During the associative stage, students have acquired the basic movement patterns and begin refining technical details through repeated practice. At this stage, the SPOC platform provides step-by-step practice guidance and self-assessment reports, enabling students to systematically improve specific movement components. In addition, online feedback from instructors enriches students' processes of reflection and adjustment, effectively integrating online and offline instructional resources. Finally, during the autonomous stage, students are capable of performing volleyball techniques with relative consistency and stability. Instruction therefore shifts toward enhancing learners' ability to apply skills flexibly in complex competitive situations. At this stage, the SPOC platform strengthens students' tactical awareness and psychological adaptability through tactical simulations, decision-making training, and analyses of high-level competition videos. These technology-enhanced instructional approaches not only improve movement fluency but also expand students' perceptual awareness and tactical thinking. Furthermore, this instructional model effectively responds to the fundamental objectives of physical education by enabling students to learn skills effectively, practice consistently, and participate regularly in competition [14].

Overall, the stage-based process of motor skill acquisition aligns closely with the blended learning strategies supported by the SPOC teaching model. Across the cognitive, associative, and autonomous stages, SPOC respectively provides foundational movement cognition, guided skill practice, and tactical application opportunities, demonstrating significant advantages in personalized instruction, stage-specific intervention, and skill transfer, while providing strong support for the integration of educational technology and the enhancement of teaching effectiveness in physical education.

3.2 Operational Mechanism of Applying the SPOC Teaching Model to the Volleyball General Course

3.2.1 Cognitive-Driven Mechanism: Promoting Technical Understanding and Tactical Construction

Supported by learning theory and cognitive psychology, the SPOC teaching model facilitates students' development of stable and accurate cognitive representations of volleyball techniques and tactics by optimizing information presentation, strengthening knowledge processing, and reducing cognitive load. Diverse instructional resources reduce ambiguity in observing technical movements, enabling students to establish clear mental representations through repeated pre-class viewing. In addition, contextualized tactical demonstrations and case-based learning tasks help students understand offensive and defensive strategies from a holistic perspective by presenting abstract tactical systems in a visualized format, thereby enhancing tactical comprehension. The core function of the cognitive-driven mechanism is to ensure that students acquire the necessary conceptual preparation before entering the classroom, allowing them to devote more cognitive resources during class to skill execution and tactical application. As a result, both learning efficiency and learning depth are substantially improved.

3.2.2 Technology-Mediated Mechanism: Enhancing Instructional Organization and Learning Support

As a technological intermediary, the SPOC platform plays a central role in resource organization, learning support, and instructional process integration. First, based on students' learning behavior data, the platform conducts learning diagnostics by visualizing students' technical proficiency, learning pace, and participation levels. These data provide instructors with reliable evidence for implementing differentiated instruction, thereby alleviating the substantial disparities in skill levels commonly observed in university volleyball general courses. Second, through mechanisms such as differentiated resource recommendation and competency-based progression, instructors can provide learning materials appropriate to students' individual proficiency levels, enabling a learning sequence characterized by mastery before advancement. Furthermore, the flipped classroom approach restructures the instructional process by shifting knowledge acquisition to the pre-class stage while reserving classroom time for practical skill training and error correction. Combined with post-class movement check-ins, performance comparisons, and personalized feedback, the platform establishes a systematic instructional process that extends beyond classroom boundaries. Overall, the technology-mediated mechanism reshapes the instructional workflow, enhances teaching organization and efficiency, and enables precision teaching alongside sustained learning support.

3.2.3 Skill Validation Mechanism: Strengthening Error Correction and Tactical Skill Transfer

The SPOC teaching model provides effective support for the acquisition, stabilization, and transfer of volleyball skills through visualized performance diagnosis and context-based application.

During classroom learning, students use instant video replay and movement comparison tools to monitor and evaluate their own technical performance, thereby improving both the accuracy and timeliness of movement correction. After class, structured learning tasks and traceable learning portfolios encourage students to continue refining technical details, facilitating the progression of motor skills toward the autonomous stage. At the tactical level, tactical simulation boards, scenario-based learning tasks, and analyses of competitive match videos enable students to progress

from merely performing isolated technical movements to effectively applying those skills in actual game situations. This development is built upon the integration of conceptual understanding with accumulated motor experience. The skill validation mechanism not only ensures the quality and stability of technical performance but also promotes the effective transfer of volleyball skills to authentic competitive contexts. Consequently, it facilitates the integration of technical execution, tactical application, competitive performance, and teamwork, thereby achieving comprehensive skill transfer in volleyball instruction.

4. Challenges in Applying the SPOC Teaching Model to the Volleyball General Course

4.1 The Impact of Technological Intervention on Embodied Learning

With its visualized, intelligent, and interactive features, the SPOC teaching model provides volleyball general courses with abundant learning resources and real-time feedback mechanisms. Students are able to repeatedly observe technical movements, complete online assessments, and receive data-driven learning analytics within a virtual learning environment. However, the defining characteristic of physical education is its embodied nature. The acquisition of volleyball skills depends not only on cognitive understanding and visual imitation but also on the body's integrated regulation of force perception, rhythm, and spatial awareness. In practice, if students rely excessively on virtual simulations and video-based imitation, they may develop a clear conceptual understanding of techniques while still performing movements rigidly and mechanically, resulting in a disconnect between knowing and doing. Such a gap weakens the accumulation of embodied experience and ultimately hinders the development of motor skills. This limitation is particularly evident in volleyball, where performance relies heavily on tactile perception and whole-body coordination. Digital media cannot fully reproduce the tactile sensation of passing, the rhythm of jumping, or the spatial judgment required during actual play.

Therefore, the instructional design of SPOC-based volleyball courses should emphasize the integration of virtual and physical learning experiences. Online instruction should primarily facilitate concept acquisition, movement decomposition, and cognitive understanding, whereas face-to-face instruction should focus on embodied experience and perceptual calibration. By integrating cognition, physical experience, feedback, and reconstruction, instructors can bridge the gap between technological mediation and bodily practice, allowing digital tools to serve, rather than replace, the embodied nature of physical education.

4.2 The Risk of Data-Driven Instruction Weakening Educational Values

A major advantage of the SPOC teaching model lies in its ability to enhance instructional precision and efficiency through learning analytics and algorithm-based feedback. Nevertheless, physical education is not merely a process of skill acquisition and efficiency improvement; it is equally concerned with character development, emotional cultivation, and value formation. Excessive emphasis on quantitative indicators and technological control may cause instructional objectives to deviate from the fundamental educational mission of physical education. For example, in volleyball instruction, students' completion of video assignments and online quizzes can be quantitatively assessed through the learning platform. However, important educational outcomes such as teamwork, competitive spirit, emotional engagement, and interpersonal interaction are difficult to capture through numerical data alone. If the evaluation system focuses exclusively on measurable learning behaviors while neglecting non-cognitive dimensions such as emotional investment and social interaction, the humanistic values of education may gradually be diminished. Accordingly, while technology empowers instruction, educators should uphold the principle that

technology serves educational development rather than replacing it, maintaining an appropriate balance between instructional efficiency and educational values. Course design should preserve opportunities for emotional communication, collaborative learning, and interpersonal interaction within physical education classes, enabling students to experience the values of sportsmanship and social engagement even within digital learning environments. For example, mechanisms such as peer assessment, reflective learning journals, and team-based performance evaluation can be incorporated into the SPOC platform to promote a balance between technological rationality and humanistic educational values.

4.3 Lagging Development of Teachers' Digital Competence

The effective implementation of the SPOC teaching model depends on teachers possessing a comprehensive set of competencies, including digital instructional design, learning analytics, and cross-platform integration. However, the current level of digital competence among university physical education teachers varies considerably. Many instructors remain at the level of basic technology use and lack systematic capabilities in instructional design and data interpretation, limiting their ability to fully exploit the pedagogical potential of the SPOC model. At the same time, university learning management platforms have yet to fully accommodate the unique characteristics of physical education courses in terms of functionality, resource sharing, and system maintenance. Many institutional platforms are primarily designed for theoretical disciplines and provide insufficient support for the real-time feedback, movement recognition, and data visualization required in skill-based physical education courses. Consequently, although teachers may be able to operate these platforms, they often struggle to optimize their instructional practices through them. This mismatch between teachers' professional competencies and technological support reflects a broader imbalance within the digital teaching ecosystem. Addressing this challenge requires coordinated efforts in three areas [15]. First, at the teacher level, universities should establish continuous professional development programs in digital pedagogy through institutional training, collaborative disciplinary research, and technology-supported teaching communities, thereby enhancing teachers' capacities for curriculum integration and reflective practice. Second, at the system level, educational platforms should be optimized to better accommodate physical education by incorporating functions such as motion capture, real-time performance diagnosis, and multidimensional assessment systems. Third, at the institutional level, universities should improve evaluation and incentive mechanisms for digital teaching innovation, providing sustained institutional support for teachers' adoption of educational technologies.

Only through the coordinated advancement of teacher capacity building, platform optimization, and institutional support can an efficient digital teaching ecosystem be established that fully aligns with the requirements of the SPOC teaching model.

5. Practical Pathways for Applying the SPOC Teaching Model to the Volleyball General Course

The application of the SPOC teaching model to the volleyball general course does not fundamentally reconstruct the instructional process; rather, it represents the practical implementation of the model's operational mechanisms within classroom teaching. Throughout the teaching process, cognitive construction, technological support, and skill reinforcement form a continuous cycle that permeates every instructional stage, enabling coordinated collaboration among different teaching functions. Accordingly, this study proposes five practical pathways for implementing the SPOC teaching model: reconstructing the instructional structure, integrating learning stages, promoting the integration of theory and practice, establishing coordinated feedback

mechanisms, and expanding instructional resources. These five pathways respectively fulfill the functions of cognitive activation, technological mediation, skill validation, and knowledge transformation, collaboratively establishing an integrated autonomous learning system that connects classroom and extracurricular learning while systematically operationalizing the proposed three-dimensional theoretical framework. Figure 2 illustrates the integrated self-organized learning system underlying the implementation of the SPOC teaching model. The five practical pathways jointly operationalize the three-dimensional theoretical framework through the mechanisms of cognitive activation, technological mediation, skill validation, and knowledge transformation.

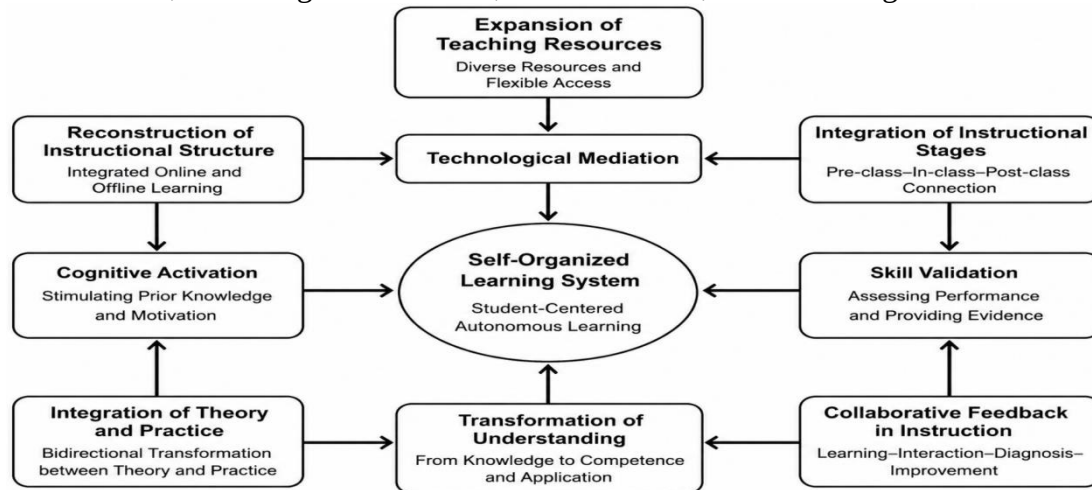


Figure 2. An Integrated In-Class and Out-of-Class Self-Organized Learning Model for Volleyball

5.1 Reconstructing the Instructional Structure

To address the limitations of traditional classroom instruction, such as restricted instructional time and relatively homogeneous teaching approaches, the SPOC teaching model reconstructs the allocation of instructional time and learning space. Supported by the technology-mediated functions of the digital platform, instructors can deliver key technical concepts, movement decomposition, and rule interpretation before class, enabling students to establish preliminary cognitive frameworks prior to classroom learning and thereby laying the foundation for subsequent skill acquisition. This approach is particularly important in volleyball general courses, where students are required not only to master complex motor skills but also to develop effective teamwork through authentic collaborative practice. By integrating online preparation, offline practice, online feedback, and offline consolidation, the SPOC model effectively enhances both learning outcomes and instructional efficiency. Specifically, before class, microlearning videos, tactical simulations, movement decomposition videos, and online rule quizzes help students establish cognitive frameworks and technical representations, equipping them with basic movement understanding and tactical awareness prior to entering the classroom. During class, instruction centers on technical practice and team cooperation. Based on students' pre-class learning performance, instructors implement differentiated instruction through real-time demonstrations, immediate error correction, and scenario-based simulations, thereby strengthening embodied skill acquisition and collaborative competence. After class, learning analytics and video replay functions enable students to review their classroom performance, while instructors provide personalized learning resources to address individual weaknesses. The resulting integrated process—linking online and offline learning as well as pre-class, in-class, and post-class activities—not only ensures instructional continuity and coherence but also overcomes the limitations of one-time classroom teaching by facilitating the

transition from conceptual understanding to skill internalization. Although this instructional design possesses broad applicability across disciplines, its practical value is particularly evident in volleyball instruction, given the complexity of volleyball techniques and the high demands of team coordination.

5.2 Integrating the Teaching Process

Building upon the reconstructed instructional structure, the SPOC teaching model integrates the entire learning process across the pre-class, in-class, and post-class stages. Through technological mediation and continuous skill validation, it connects each phase of learning into a coherent instructional system. The online platform coordinates the overall learning process, regulates learning progress, and ensures instructional continuity through digital technologies.

Traditional volleyball instruction often separates pre-class preparation, classroom learning, and post-class practice, resulting in fragmented and discontinuous learning experiences. In contrast, the SPOC platform integrates these three instructional stages through technological support and learning analytics, establishing a unified instructional system that continuously reinforces skill validation. During the pre-class stage, students build cognitive frameworks through microlearning videos, movement decomposition videos, virtual tactical simulations, and online self-assessments, thereby reducing cognitive demands during classroom instruction. During class, instruction emphasizes practical skill training and tactical cooperation. Based on students' pre-class learning data, instructors implement differentiated teaching strategies by assigning training tasks appropriate to different proficiency levels. Real-time learning analytics enable immediate validation of technical performance, while classroom feedback and collaborative practice improve both instructional interaction and learning efficiency, allowing students to promptly correct technical errors. During the post-class stage, learning analytics and individual learning trajectories help identify technical deficiencies and gaps in tactical understanding. The platform subsequently recommends personalized learning resources and training tasks, enabling students to refine their skills through repeated practice and ultimately achieve skill internalization and transfer. Digital technologies integrate learning data across all instructional stages, supporting post-class reflection and continuous skill assessment. This integrated three-stage instructional model overcomes the fragmented nature of traditional volleyball instruction and establishes a coherent learning system. On the one hand, it stimulates students' motivation for autonomous learning while ensuring continuity throughout the learning process. On the other hand, it provides instructors with sufficient evidence for precision teaching and differentiated guidance, enabling continuous skill monitoring and closed-loop competency development.

5.3 Integrating Theory and Practice

The disconnect between theoretical instruction and practical application has long been a common challenge in physical education. Through the integration of theory and practice, the SPOC teaching model establishes close connections among conceptual knowledge, technical skills, and practical application, enabling a bidirectional transformation in which theory guides practice while practice reinforces theoretical understanding. Based on the proposed three-dimensional theoretical framework, theoretical learning primarily fulfills a cognitive activation function by establishing systematic conceptual structures, whereas practical activities validate and refine students' existing understanding, thereby facilitating cognitive transformation. As volleyball requires both technical proficiency and tactical competence, effective learning depends not only on repeated physical practice but also on a deep understanding of movement principles and tactical logic. Traditional volleyball instruction often separates theoretical lectures from technical training, reducing

theoretical learning to conceptual memorization and practical instruction to mechanical imitation, thereby preventing students from integrating knowledge with skill acquisition. The SPOC teaching model effectively addresses this problem. During theoretical learning, the digital platform presents complex volleyball knowledge in modular and visualized formats. Animated demonstrations illustrate blocking timing and movement patterns, while virtual tactical simulations deconstruct offensive systems, enabling students to establish intuitive conceptual understanding before class. During classroom practice, students immediately apply theoretical knowledge to technical training and tactical cooperation. Based on learning analytics, instructors conduct precise diagnoses and provide real-time feedback to correct common technical errors. For example, in spike instruction, instructors can identify deficiencies in jumping rhythm through platform data and subsequently provide targeted training on the coordinated sequence of approach, take-off, and ball contact. During the post-class feedback stage, students review movement recordings, compare their performance with standard demonstrations, and complete theoretical self-assessments, thereby reconnecting practical experience with conceptual knowledge and promoting the bidirectional transfer of cognition and skill.

This integrated instructional model deepens students' mastery of volleyball techniques while improving their ability to apply tactical knowledge in authentic competitive situations. Given the technically demanding and highly collaborative nature of volleyball general courses, the integration of knowledge and practice closely aligns with course objectives and fully demonstrates the unique instructional value of the SPOC model in combining cognitive activation with conceptual transformation.

5.4 Coordinating Instructional Feedback

High-quality instruction depends upon an effective feedback system. The SPOC teaching model establishes an integrated operational framework combining learning, discussion, and assessment, thereby creating a continuous feedback loop of learning–interaction–diagnosis–improvement that enhances both openness and reflective learning throughout the instructional process. Coordinated feedback not only verifies students' technical performance but also reconstructs their cognitive understanding through continuous reflection, thereby promoting sustained technical improvement through conceptual transformation. Traditional volleyball instruction often separates learning, discussion, and assessment. Learning focuses primarily on technical practice, discussion remains confined to classroom settings, and evaluation relies predominantly on final examinations while neglecting continuous formative feedback. The SPOC platform integrates these three components into a unified feedback system in which learning provides the foundation, discussion deepens understanding, and assessment supports continuous skill validation. During the learning phase, students preview microlearning materials online, imitate standard techniques, and upload training videos after class, thereby establishing comprehensive learning portfolios that provide process-oriented evidence for assessment. Through continuous performance records, students reconstruct their technical understanding by reviewing their own movement videos, facilitating the transformation of practical experience into theoretical understanding. During the discussion phase, online group discussions, instructor consultations, and peer assessment enable students and instructors to exchange ideas regarding technical execution and tactical cooperation. Students evaluate one another's performance in areas such as setting and defensive positioning, while instructors provide targeted guidance based on discussion outcomes. During the assessment phase, learning analytics, discussion records, and technical performance evaluations are integrated to balance formative and summative assessment. Instructors identify learning difficulties through students' learning trajectories and provide intuitive visual feedback through skill development

curves and learning radar charts. Students subsequently adjust their training plans based on multidimensional evaluation results.

This integrated feedback system transforms volleyball instruction from simple technical transmission into an open and dynamic interactive learning environment, continuously strengthening the skill validation cycle and supporting students' steady development of specialized volleyball competencies.

5.5 Expanding Instructional Resources

Improving the quality of volleyball instruction requires the expansion of both learning resources and learning environments. Leveraging its digital capabilities, the SPOC teaching model establishes an open and shared resource system together with flexible learning opportunities across time and space. Resource expansion represents an external manifestation of the technology-mediated function, whereby digital platforms integrate, distribute, and intelligently allocate learning resources while overcoming the physical constraints of traditional classrooms and providing comprehensive learning support. University volleyball general courses commonly encounter challenges such as limited instructional hours, insufficient practice facilities, and substantial differences in students' technical abilities, all of which constrain instructional effectiveness. The digital and network-based characteristics of the SPOC platform effectively overcome these limitations. In terms of instructional resources, the platform integrates multi-angle technical videos, virtual tactical simulations, and instructional cases into a comprehensive resource library covering fundamental techniques, advanced tactics, and integrated practical training. Students are able to repeatedly observe and imitate technical movements outside the classroom, thereby reinforcing skill proficiency. Regarding learning methods, the platform employs big-data analytics to provide personalized instructional content. Based on students' technical deficiencies in skills such as forearm passing and spiking, the system automatically recommends individualized microlearning materials and training programs, precisely addressing students' weaknesses while dynamically aligning instructional content with individual learning needs through technological mediation. From a spatiotemporal perspective, mobile devices and online learning platforms eliminate the constraints of classroom schedules and physical facilities. Students can practice independently and participate in online discussions both on and off campus during their spare time, while instructors monitor learning progress remotely and provide timely guidance and feedback through cloud-based platforms. Technology-mediated instruction thus reshapes learning schedules and expands learning environments, allowing volleyball skill development to extend beyond traditional classroom settings into diverse learning contexts.

In summary, by establishing an integrated in-class and out-of-class self-organized learning system for the volleyball general course, the SPOC teaching model effectively addresses the limitations of traditional volleyball instruction. It strengthens students' autonomous learning capabilities, promotes the deep integration of technical skills and tactical understanding, and facilitates the coordinated development of motor skills, tactical cognition, teamwork, and lifelong interest in physical activity, thereby demonstrating the profound value of integrating modern educational technology with physical education.

6. Conclusion

Using the university volleyball general course as its research context, this study explored the theoretical logic and practical implementation of the SPOC teaching model and developed an instructional framework centered on integrated in-class and out-of-class learning and self-organized learning. The findings indicate that the SPOC model effectively promotes the deep integration of

online and offline instruction, optimizes instructional structures and learning processes, and enhances students' technical proficiency, tactical understanding, and learning initiative, thereby providing a practical model for the digital transformation of university physical education. Nevertheless, several limitations remain. First, the study focuses exclusively on the volleyball general course, and the representativeness of the sample as well as the applicability of the proposed model across different sports courses require further verification. Second, the data primarily rely on behavioral records collected from the learning platform, with insufficient attention given to learning transfer, motivational mechanisms, and long-term instructional outcomes. Third, the implementation of the SPOC teaching model continues to face practical constraints, including unequal distribution of instructional resources and relatively limited evaluation systems. Future research should examine the applicability of the SPOC model across multiple sports disciplines and institutional contexts, thereby expanding the scope of digital applications in physical education. Greater emphasis should also be placed on intelligent learning analytics, data-driven assessment, and the development of teachers' digital competencies to facilitate the transition of physical education from digital empowerment toward intelligent optimization. In conclusion, the integration of the SPOC teaching model not only reconstructs the structural logic of university physical education but also provides sustainable theoretical support and practical pathways for the reform of physical education curricula in the era of educational digitalization.

Acknowledgement

Funding: This research was supported by the General Teaching Reform Research Project for Regular Undergraduate Universities in Hunan Province (Grant No. 202401001127) and the Key Teaching Reform Research Project for Regular Undergraduate Universities in Hunan Province (Grant No. 202502001052).

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