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Enhancing Instructional Quality in Macro-Unit Physical Education: Pathways Informed by Nonlinear Pedagogy

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Abstract

The *Physical Education and Health Curriculum Standards for Compulsory Education (2022 Edition)* emphasize that diversified teaching approaches play an essential role in guiding students to think independently and engage in self-directed practice, thereby fostering their comprehensive practical competence and innovative awareness. Accordingly, traditional single-mode instruction, in which teachers demonstrate and students imitate, must be transformed. Against this backdrop, the present study employs the methods of literature review, experimental research, and logical analysis to investigate the application paradigm of ecological dynamics theory in physical education. The primary manifestation of ecological dynamics in this field is nonlinear pedagogy. The findings indicate that nonlinear pedagogy, through a constraint-led mechanism (the triadic constraints of individual–environment–task), effectively addresses the common dilemmas in teaching—namely, weak student interest, disconnection between learning contexts and skill application, and overly lengthy instructional tasks—by focusing on three dimensions: constructing high-quality learning situations, reinforcing task degeneracy, and stimulating students' self-organization. Based on these findings, the application of this teaching approach contributes to enhancing students' exploratory engagement and capacity for self-organization, promotes positive transfer of motor skills, and provides both theoretical support and practical reference for the optimization of large-unit teaching models in physical education.

Keywords: ecological dynamics; nonlinear pedagogy; constraint-led approach; physical education large-unit teaching

1.Introduction

The 2022 *Physical Education and Health Curriculum Standards for Compulsory Education* (hereafter, the 2022 Standards) call for strengthening students' comprehension and practical abilities, cultivating transfer of learning and integrative thinking, and promoting the application of acquired knowledge and skills to daily life. The Standards signal a shift from knowledge- and skill-centered instruction to student development as the primary objective, emphasizing student agency and attention to individualized, diverse learning needs. They also establish behavioral benchmarks for physical-education teaching at the compulsory-education stage and for national talent development in sport. A persistent gap separates the ideal classroom from routine practice. In physical education, extended class time and overloaded content have been linked to diminished student interest (Jiang & Zhu, 2024). Insufficiently designed learning contexts and inadequate pedagogy further limit engagement and effectiveness (Mao et al., 2022). Although learner-centered principles are widely endorsed, teacher-dominated instruction remains common, leaving individual differences unaddressed (Tan et al., 2024). Proposed solutions—such as a "streaming" or track-based system to enhance interest, avoid low-level repetition, and integrate courses—show promise but are constrained by economic conditions, geography, and school infrastructure, limiting broad implementation (Mao et al., 2023). "Big-idea" teaching has likewise been advanced to strengthen teachers' and students' grasp of underlying principles, yet in practice it can render already dense, finely specified large-unit curricula more abstract and difficult to deliver. Ecological dynamics, originating in Gibson's ecological approach to visual perception, conceptualizes human behavior as responsive to, and reciprocally shaped by, the environment. Within this framework, behavior emerges through perception–action coupling, and changes as environmental conditions change (Chen, 2023). Individuals are understood not only as perceivers of the environment but also as co-creators of it (Renshaw I & Chow,2019). Applied to school physical education, ecological dynamics is most commonly instantiated as nonlinear pedagogy (NLP) (Ye & Jia, 2023). NLP emphasizes exploratory learning and self-organization by regulating interacting constraints across the individual, task, and environment to elicit adaptive behavior (Yang et al., 2025). Despite growing interest in this perspective, few studies have aligned suitable theory with large-unit teaching, and fewer still have used theory-driven pedagogy to structure and deliver such units.

Against this backdrop, we propose applying NLP within ecological dynamics to physical-education instruction to enhance students' interest, overall adaptability, and innovative capacity. In this view, teachers design learning environments, and students actively mine those environments for information; the individual is both perceiver and creator within the individual–environment relationship (Renshaw I & Chow,2019). Using literature review, experimental methods, and logical analysis, this study (1) designs multidimensional, high-quality learning situations to mitigate learning fatigue and raise interest; (2) introduces task degeneracy to counteract extended periods and overloaded content characteristic of large-unit teaching; and (3) cultivates student self-organization to move beyond teacher-dominated instruction and foster innovation. Our aim is to employ NLP to increase instructional efficiency, strengthen core competencies, and contribute to the cultivation of sporting talent in a nation committed to excellence in sport.

2. Research methods

We enrolled 240 third-grade students from five intact classes at Chaoyang Primary School (Beibei District) to receive a two-month intervention using nonlinear pedagogy; outcomes were compared with five non-intervention (usual-instruction) classes. Within each arm, a subset of representative students was selected for detailed analysis. All participants were members of regular teaching classes and followed school-mandated lesson content. Stratified sampling was used: classes were grouped according to their team results in the school sports meet to approximate equivalence in baseline motor ability between intervention and control groups. Fifty tennis rackets, 200 tennis balls, one standard court, cones/markers, long ropes, and child-sized rackets. Fundamental tennis strokes, focusing on forehand and backhand groundstrokes. Experimental evaluations of nonlinear pedagogy in domestic physical-education settings remain limited, yet experimental evidence can be particularly persuasive. The feasibility of the present design was supported by the author’s role as a practicing teacher. Accordingly, an experimental approach was adopted to test whether nonlinear pedagogy can feasibly and effectively improve the quality of large-unit PE instruction. The scoring rubric was adapted from the Chongqing Municipal Physical Education College Entrance Examination standard for tennis, with minor modifications to align with the abilities and context of the study school, thereby maximizing content relevance and fit.

2.1 Research design

Lesson plan	Experimental group content	Control group content
Lesson 1	Forehand baseline rally practice: students are only required to return the ball into the opponent’s court, without focusing on placement or detailed stroke mechanics.	Stationary multi-ball practice: teacher instructs according to the standard forehand stroke technique, emphasizing detailed movement execution.
Lesson 2	Forehand rally practice: students are required to return the ball to the opponent with a forehand stroke; the teacher restricts the rally area to the service box.	Stationary multi-ball practice: teacher closely monitors students’ actions and places quality requirements on students’ strokes.
Lesson 3	Teacher asks students to reflect on how racket face angle affects high/low shots. Students summarize independently, while the teacher uses the net as a constraint to limit excessive ball height.	Moving multi-ball practice: teacher requires students to use lateral footwork to reach the ball and then strike into the effective area with quality.

Summary of the first week: The experimental group had a lively classroom atmosphere, with

frequent communication between samples and diverse techniques. The control group had smooth communication and standardized techniques.

Lesson plan	Experimental group content	Control group content
Lesson 4	Teacher sets up a match scenario: groups compete to see which group achieves more rallies. No fixed technical requirements are imposed; students are told that the goal is to sustain rallies, not to score points.	Match scenario: students are required to win by producing more rallies, rather than focusing on ball quality. Teacher provides reminders on students’ technique.
Lesson 5	Court width reduced to half-court; students are required to use forehand strokes to return balls into the effective area.	Forehand moving multi-ball practice: teacher reminds students of technique, then organizes group rallies. Students must

		sustain rallies while maintaining ball quality.
Lesson 6	Students use rackets with modified racket faces to increase audience engagement. This enables students to experience a realistic match atmosphere; backhand instruction begins.	Forehand multi-ball fixed-line drill: students practice fixed forehand stroke patterns. Teacher emphasizes shot placement and depth, while also beginning backhand instruction.

Week 2 Summary: The experimental group showed strong interest and engaged in more rounds of sparring, with more diverse scoring methods. The control group demonstrated a high degree of student skill and was able to practice according to the teacher's instructions, demonstrating consistent movement during competition.

Lesson plan	Experimental group content	Control group content
Lesson 7	Teacher arranges a draw for students to determine opponents and conducts a match. Scoring is only allowed after three rallies. Students must find their own ways to handle backhand shots during the match.	Teacher arranges a draw for matches. Students are required to return the ball to the opponent's forehand as much as possible. Attacking is only allowed after three rallies.
Lesson 8	A line is placed 1 meter above the net; students adjust shot height according to the situation. Backhand returns are required to follow specific trajectories.	Teacher strengthens forehand technique, correcting students' movements. Students must return with quality and perform moving backhand shots.
Lesson 9	Backhand instruction: teacher does not prescribe fixed techniques. Students explore independently, with scenarios designed according to their hitting performance to constrain strokes.	Teacher conducts stationary multi-ball practice, reminding students about stroke quality. Teacher demonstrates model strokes so students understand which shots are of the highest quality.

Week 3 Summary: The experimental group showed a variety of playing styles and scoring methods, with more back-and-forth play. The control group showed high-quality movements, high-quality balls, and fewer rounds.

Lesson plan	Experimental group content	Control group content
Lesson 10	Backhand rally practice: students are required to return balls into a fixed area set by the teacher. No strict requirements on backhand stroke details.	Moving multi-ball practice: students are required to move naturally and adjust footwork to return balls into the effective area. Teacher also places quality requirements on strokes.
Lesson 11	Practice in fixed areas and at fixed heights. Matches are organized with audience participation. Students are encouraged to explore backhand techniques independently while playing in front of spectators.	Teacher organizes net rallies, requiring students to hit balls into effective areas. During matches, the teacher reminds students of technical requirements and ensures movement quality.
Lesson 12	This lesson includes a basic skill test for both experimental and control groups. 1. Test items: (1) 10 forehand strokes from baseline while moving; (2) 10 backhand strokes from baseline while moving; (3) 10 alternating forehand and backhand strokes while moving.	Teacher conducts net rallies with students, requiring them to place the ball into the effective area. During matches, the teacher consistently reminds students of technical movements, ensuring proper execution.

2. Test requirements: (1) Out-of-bounds = 0 points; (2) Ball lands in service area = 1 point; ball not in service area = 0.5 points. 3. Technical scoring: total = 10 points. Rating ≥ 8 = 9 points; rating 7–7.5 = 7–8.9 points; rating ≤ 6.9 = 6 points or below. 4. Final score: sum of points from each test item and corresponding technical score.

3. Results

The fourth week is a mid-term assessment, primarily assessing students' basic skills. The overall performance data is as follows:For example, the experimental group:

Student Name	Baseline Forehand / Score	Baseline Backhand / Score	Baseline Alternating / Score	Total
A1	8/9.5	9.5/9.5	7/7	50.5
A2	8/9	7/7	8/9	48
A3	6.5/7	9/9	8/9	49.5
A4	8/9	8.5/9	8/9	51.5
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
A20	9/9	9/9	8/9	53

For example, the control group:

Student Name	Baseline Forehand Score	/Baseline Backhand / Score	Baseline Alternating / Score	Total
B1	7/8.5	8/9.7	7/8.6	48.8
B2	6/8.4	7/8.9	7/8.7	46
B3	7/8.9	8/9	8/9.5	50.4
B4	8/9.7	8/9.5	7/8.9	51.1
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
B20	8/9	9/9	8/9	52

The basic technical scores of the experimental group and the control group were statistically analyzed.

Forehand Score Range Comparison	Backhand Score Range Comparison	Alternating Score Range Comparison
≥ 9 points	6/2	6/1
8–8.9 points	7/7	8/8
7–7.9 points	6/11	6/12
≤ 7 points	1/1	1/3

Statistics comparing basic skills between the experimental and control groups revealed that the experimental group's scores in the high-scoring range were higher than those of the control group. A few of the experimental group's scores in the middle-scoring range were the same, while the rest were lower. The experimental group's scores in the low-scoring range were slightly higher than those of the control group.

This indicates that the experimental group's scores in the high and low-scoring ranges of basic skills were higher than those of the control group, while the control group's scores in the middle range were higher than those of the experimental group. This is attributed to the experimental group's use of a nonlinear teaching model, where teachers primarily emphasize achieving skill goals without requiring specific methods for achieving them. Furthermore, teachers fostered students' exploratory potential in instruction, encouraging them to actively explore knowledge within the context of movement rather than passively absorb it.

Skill evaluation scores for the experimental and control groups were statistically analyzed.

Forehand Technique Comparison	Backhand Technique Comparison	Alternate Technique Comparison
≥ 9 points 15/9	15/13	14/8
8–8.9 points 1/10	0/6	1/11
7–7.9 points 5/0	5/0	5/1
≤ 7 points 1/0	2/0	1/0

A statistical analysis of the skill evaluations of the experimental and control groups revealed that, except for the high-scoring range, the experimental group's skill evaluations were higher than the control group's in all other score ranges. This suggests that the overall skill evaluation of the experimental group was lower than that of the control group. This is attributed to the experimental group's use of a nonlinear teaching model, which emphasizes the nonlinear nature of skill acquisition. The teacher emphasizes goal achievement rather than strict technical requirements. The control group's teacher, however, rigorously enforced basic movement during instruction, resulting in higher skill evaluations for the students in the experimental group.

Second-phase Learning Plan

Lesson Plan	Experimental Group Content	Control Group Content
Lesson 13	Forehand and backhand multi-ball practice. Emphasize that the ball trajectory is irregular and the variations are significant. Students are required to adapt on their own and make the correct choice to return the ball into play.	Teachers reinforce forehand and backhand teaching, requiring students to control shot direction and ball depth. Teachers promptly correct student actions. Based on competition findings of technical weaknesses, multi-ball training is adopted, applying different methods for different issues. Competitions are further used to regulate and apply techniques.
Lesson 14	Teachers set up different teaching scenarios according to various ball conditions, such as reducing court size, lowering the net height, increasing shot difficulty, adjusting audience atmosphere, and creating unfavorable external conditions for students.	Competitions are used to identify students' technical weaknesses, followed by multi-ball drills addressing specific problems with targeted solutions. Competitions are then used to reinforce proper technical execution and application.
Lesson 15	Students are taught in stratified groups according to ability. A rotation system is implemented, with additional adjustments to enhance audience engagement and atmosphere.	Students are divided into groups by drawing lots. Competitions are conducted using an elimination format.

Week 5 Summary: The experimental group had average line control, strong stability, and a beginning technical combination. The control group had clear lines, good ball quality, fast ball speed, but lacked stability.

Lesson Plan	Experimental Group Content	Control Group Content
Lesson 16	Based on the competition situation from the previous lesson, students are regrouped for new instructional scenarios. Students with similar issues are grouped together, and restrictive methods are adopted for teaching or competition.	Adjust the training plan according to the competition situation. For consistency, explicitly instruct students to add topspin to their shots and remind them to finish their strokes.
Lesson 17	The teacher conducts multi-ball drills across the net, requiring students to hit the ball higher. In the front court, students act as blockers, requiring others to hit over their heads. Students practice forehand and backhand strokes to experience different conditions.	The teacher conducts multi-ball drills, requiring students to hit clear paths with forehand strokes, while ensuring shot quality and proper movement.
Lesson 18	The teacher places a line one meter above the net. Students must hit the ball through the gap between the net and the line, experiencing different hitting methods.	Students practice forehand and backhand movement drills with fixed landing points. Students are required to return in position without altering their form.

Summary of Week 6: The experimental group's classroom was active and the technology was flexible. The control group's classroom atmosphere was divided and the technology was stereotyped.

Lesson Plan	Experimental Group Content	Control Group Content
Lesson 19	The teacher trains students to hit fixed points while moving, placing obstacles in the front court and specifying return paths. Within groups, students are assessed based on skill level.	The teacher further reinforces students' hitting actions, providing corrections for individual errors such as hitting out or into the net.
Lesson 20	Enhance audience atmosphere and change court size for practice. Students practice attacking on a smaller court while the defending side remains unchanged.	The teacher organizes competitions by ability groups, identifying real issues students face during matches.
Lesson 21	Reduce racket size and hitting area to improve students' shot accuracy. During intra-group competitions, deliberately add unfavorable conditions (court size, sunlight, point handicap) to challenge students.	Based on the previous match, the teacher summarizes observed problems: students’ poor stability, improper footwork, or psychological factors leading to inaccurate hitting. Targeted training is then provided.

Week 7 Summary: The experimental group was able to proactively respond to artificially set challenges and demonstrated strong adaptability. The control group demonstrated standardized actions and strong execution.

Lesson Plan	Experimental Group Content	Control Group Content
Lesson 22	Group members share their approaches to handling different types of balls. The teacher acts as a listener, then designs scenarios based on students' feedback.	The teacher explains how students should handle different types of incoming balls, including shot selection, footwork, and racket trajectory, providing detailed instruction.
Lesson 23	Students freely choose opponents for a best-of-seven competition. During the match, the teacher engages the audience to strengthen psychological resilience training.	The teacher applies the methods explained in the previous lesson to targeted multi-ball practice. During training, the teacher continuously reminds students of proper technical movements.
Lesson 24	The experimental and control groups compete against each other. Students are regrouped to balance strengths. Competition rules: best-of-seven games, first to 7 points wins. Teams are divided into four subgroups based on skill levels, with the top two from each group advancing. Results are analyzed afterward.	The teacher organizes competitions based on previous group performance. Competition format: best-of-seven, first to 7 points. Students are divided into four skill-based subgroups, and the top two advance. Results are analyzed at the end.

Group A match table

Participants	Score	Technical Statistics
A6 VS B13	7 : 6	Experimental group: 1 control point, 1 non-forced error, 5 forced errors, 4 rally wins, 2 unregulated hits Control group: 1 forced error, 6 non-forced errors
A10 VS B11	5 : 7	Experimental group: 2 non-forced errors, 5 forced errors, 4 rally wins, 1 unregulated hit Control group: 3 forced errors, 5 non-forced errors, 2 unregulated hits, 2 rally wins
A20 VS B6	7 : 4	Experimental group: 1 control point, 6 rally wins Control group: 3 control points, 1 rally win
A13 VS B8	7 : 5	Experimental group: 5 rally wins, 2 unregulated hits Control group: 3 control points, 2 rally wins
A15 VS B7	7 : 6	Experimental group: 4 rally wins, 1 control point, 2 unregulated hits Control group: 3 control points, 3 rally wins

Analysis of Group A's Matches: Analysis of the results shows that the experimental group had a greater chance of winning and employed significantly more unconventional shots than the control group. Their on-court performance also showed a strong ability to regulate themselves, managing their emotions well even when trailing. The control group displayed standard techniques and high-quality shots, resulting in more winning shots but also making more unforced errors.

Group B Match Schedule

Participants	Score	Technical Statistics
A9 VS B20	7 : 5	Experimental group: 4 rally points, 1 unforced error, 1 fault Control group: 2 forcing points, 2 rally points
A5 VS B4	7 : 5	Experimental group: 5 faults, 2 rally points, 3 unforced errors Control group: 2 forcing points, 1 fault, 2 rally points
A4 VS B14	3 : 7	Experimental group: 1 fault, 4 unforced errors Control group: 5 forcing points, 2 rally points
A1 VS B3	7 : 6	Experimental group: 5 rally points Control group: 2 unforced errors
A11 VS B5	5 : 7	Experimental group: 4 rally points, 1 fault, 1 unforced error Control group: 4 forcing points, 2 rally points

Analysis of Group B's matches: Match analysis revealed a significant variation in the return styles of the experimental group, particularly in the match between A5 and B4. A5's ball quality posed no threat to B4, leading to a brief period of decline. However, A5 ultimately turned the tables by employing a consistent forehand and backhand slice. The control group scored more points in rallies and showed greater ball consistency. Some students also demonstrated unconventional strokes, excelling at observation and imitation.

Group C Match Table

Participants	Score	Technical Statistics
A14 VS B15	4 : 7	Experimental Group: 4 passive errors, 3 forced errors Control Group: 3 winning shots, 4 rallies won
A7 VS B1	7 : 6	Experimental Group: 3 unforced errors, 1 winning shot, 2 passive errors Control Group: 3 passive errors, 1 forced error, 4 winning shots
A3 VS B17	7 : 5	Experimental Group: 5 rallies won, 1 unforced error Control Group: 1 passive error, 2 winning shots, 3 rallies won
A12 VS B9	7 : 6	Experimental Group: 5 rallies won Control Group: 5 winning shots, 1 passive error
A19 VS B12	7 : 3	Experimental Group: 5 unforced errors, 2 rallies won, 3 forced errors Control Group: 5 passive errors, 1 winning shot

Analysis of Group C Matches: The experimental group's primary scoring method was rallies. A19 and A14 were the most unconventional players, but A19's victory was due to the quality of their returns. The control group's technique was standardized, resulting in more winning shots. However, their scores decreased after rallies, with more unforced errors.

Group D Match Schedule

Participants	Score	Technical Statistics
A16 VS B2	3 : 6	Experimental group: 3 non-forced errors, 3 forced errors Control group: 3 winning shots, 2 sustained points, 1 unconventional shot
A2 VS B16	5 : 7	Experimental group: 4 forced errors, 1 sustained error, 2 winning shots Control group: 3 winning shots, 3 unforced errors
A8 VS B19	4 : 7	Experimental group: 3 winning shots, 5 forced errors Control group: 5 winning shots, 1 forced error, 2 sustained points

A18	VS7 : 6	Experimental group: 5 sustained points, 3 forced errors, 3 unforced errors
B18		Control group: 2 forced errors, 3 winning shots
A17	VS5 : 7	Experimental group: 4 sustained points, 4 forced errors
B10		Control group: 1 forced error, 3 winning shots

Analysis of Group D Matches: The experimental group showed strong technical consistency overall, but their ball quality was low. This was particularly true when changing their technique, resulting in poor returns and errors. However, student A18's fundamental technique was significantly inferior to that of student B18. Although he initially lagged behind, he ultimately emerged victorious through superior stability and stamina. The control group scored primarily through winning points and establishing an advantage.Overall Analysis: Analysis of matches across the four groups revealed the following technical characteristics of the experimental group: 1. High return variability; 2. A high proportion of rallies; 3. Strong application of technique and transferability; 4. A high incidence of unconventional strokes. The control group exhibited the following technical characteristics: 1. Standardized technical movements; 2. Overall high forehand and backhand quality; 3. A high proportion of winning points; 4. A high incidence of unforced errors. From this we can see that the nonlinear teaching method gives full play to the subjectivity of students, enabling them to actively explore and dig out knowledge in the scenarios set by teachers rather than blindly accepting it; secondly, nonlinear teaching is also conducive to students building good psychological qualities; finally, it also shows good performance in students' flexible use of technology and transfer of skills.

4. Logical Point of Departure and Practical Challenges in Large-Unit Physical Education Teaching

4.1 Logical Point of Departure

Large-unit physical education (PE) teaching represents a substantive departure from traditional lesson-by-lesson instruction. Its core is operationalizing “teach well, practice diligently, and compete regularly” to remedy four entrenched shortcomings of conventional teaching—excessive content, undue difficulty, bias, and superficiality (Mao et al., 2023). The concept is not new; it has passed through stages of emergence, stagnation, and development. In China, Mao first argued in 1994 that unit scales were too small, producing duplication of materials, shallow learning, and student aversion; he advocated expanding the instructional unit. Research then slowed until 2014, when the era of “core competencies” revived interest. The 2022 *Physical Education and Health Curriculum Standards* explicitly require no fewer than 18 class periods per unit for students at Level II and above, thereby providing detailed specifications for objectives, content, and assessment and a programmatic basis for subsequent work (Mao, 1994).With the new standards, scholarship has expanded. Some have urged that large-unit teaching be organized around authentic learning tasks, with structured content and observable goals to guide theme-based learning (Ministry of Education of the People’s Republic of China, 2022). Their work distills design essentials across four dimensions—theme, task, content, and objectives. Building on this, others have synthesized elements from sport education, teaching for understanding, and personal-social responsibility models to shape a PE-and-health pedagogy suited to large-unit instruction (Zhang & Chen). This approach varies learning contexts across developmental stages, simplifies game rules, emphasizes skill application, and promotes transfer of learned skills to daily life. In short, grounded in core competencies, large-unit PE increasingly stresses diverse, real-world contexts, economical (non-redundant) task design, and skill transfer.

4.2 Practical Challenges

Despite progress, teaching is inherently nonlinear—complex and variable—and new problems surface over time. Commonly cited challenges include extended units and overloaded content that dampen interest (Zhou et al., 2024) weakly designed learning contexts and inadequate methods (Jiang & Zhu, 2024); and the persistence of teacher-dominated instruction despite widespread endorsement of learner-centered ideals, leaving individual differences insufficiently addressed (Mao, et al., 2024).Targeted remedies have been proposed. To counter long units and overstuffed content, some advocate organizing large-unit teaching under “big ideas” to connect otherwise dispersed materials across levels and align knowledge with skills (Tan er al., 2024). Yet this raises demands on teacher expertise and risks adding abstraction to already dense units. To enrich contexts and methods, others propose a “context chain” grounded in situated cognition, situative learning, and learning progression theories—sequencing life-based contexts, simulated competition, and authentic competition (Jiang & Zhu, 2024). This taxonomy offers useful guidance for subsequent practice. To address individual differences under the equity ethos, stratified and track-based teaching across classes, within-class tiered instruction, and hierarchical assessment at the individual level have been suggested (Tan et al., 2024). Such measures, however, presuppose robust facilities and staffing, limiting feasibility in many under-resourced schools and explaining the lack of widespread adoption. Our review and classroom observations indicate a central gap: the absence of an overarching instructional method to steer large-unit PE. Because pedagogy powerfully shapes instructional quality, a nationally promoted large-unit approach urgently requires a compatible method to guide teachers and improve outcomes.

4. 3Nonlinear Pedagogy in Physical Education: Core Meanings and Pathways

Nonlinear pedagogy (NLP) offers a transformative approach. By configuring the reciprocal influences among environment, task, and individual, NLP treats learning as a nonlinear process and adopts an outcome-oriented stance: what matters is attainment of functional performance goals, not prespecifying a single technical route for all learners (Tan et al., 2024). Crucially, NLP is not laissez-faire. Distinct from “hands-off” instruction, it employs constraint-led guidance to channel learners’ exploration toward personally effective movement solutions; this constraint-led element is the method’s core (Lee et al., 2014). In doing so, NLP maximizes exploratory behavior and agency, centers the learner, and establishes clear bounds for exploration.Large-unit PE urges “learn–practice–compete” within authentic contexts. Yet in many sport-specific units, context design is generic, decoupled from content, or at odds with skill acquisition. The structural rigor that large units aim to deliver can collide with students’ need for creative problem solving. Teachers should lead rather than micromanage; however, prescriptive “teaching determines learning” often clashes with students’ self-organization. Accordingly, we propose three NLP-aligned emphases for sport-skill learning within large units: (1) design high-quality representative learning contexts; (2) streamline instructional frameworks; and (3) make the learner the primary actor to catalyze self-organization and genuine implementation at scale (Pinder & Renshaw, 2019).

4.4 Pathway Exploration for Large-Unit Teaching with NLP

Traditional PE contexts tend to be single-sided and de-contextualized, encouraging mere imitation of demonstrated actions (Luo & Deng, 2020). For example, in standing long-jump lessons, a “frog-jumps-tolilies” vignette is often staged: the teacher demonstrates, then prescribes arm swing and take-off mechanics; the “context” becomes decor unrelated to skill acquisition or goal attainment. Such designs neither cultivate active information pick-up nor foster exploratory learning.Ecological dynamics provides the theoretical base for NLP by foregrounding the individual–environment relationship (Chow et al., 2022). NLP therefore calls for *representative* learning contexts aligned with the instructional goal. Practice divorced from the performance environment yields limited transfer; athletes routinely seek pre-competition familiarization precisely for this reason. In NLP, environmental complexity is an asset: students actively explore as information *seekers*, while teachers act as designers of constraints (Renshaw & Chow, 2019). Because skill acquisition hinges on perception–action coupling, context design should begin from students’ interests and task goals, and invite multiple individualized solutions to reach predefined outcomes.In NLP, *task simplification* aims to support successful whole-skill execution while preserving performance integrity, in contrast to *task decomposition*, which breaks an action into parts and later reassembles them (Kaloka et al., 2025). In practice, many large-unit plans merely expand textbook units: teachers subdivide existing content to meet the 18-lesson requirement, producing fragmented modules with bloated content, weak progression, and no coherent execution framework (Wu et al., 2022). Theoretical work cautions that the “minimum unit scale sufficient for quality teaching” is optimal—and may shrink as teacher expertise and instructional management improve. If larger units become inefficient and diffuse, the approach is counterproductive (Zhang et al., 2022).The point is not to dispute the 18-lesson guideline but to diagnose a design problem. Where units are long and patchworked, tasks should be *optimized and simplified*. For instance, instead of teaching chest pass, bounce pass, and overhead pass in separate basketball lessons, teachers can stage a game-like passing task in which learners select passing modes based on emergent affordances. This trims content, enhances exploration, and maintains performance relevance.

4.5 Self-Organization and Adaptive Movement Behavior

“Self-organization,” introduced to the sciences by W. Ross Ashby, in learning denotes purposeful, autonomous regulation of behavior to achieve effectiveness—through clear goal setting, appraisal of one’s capacities, and planning and control of actions (Ishkov, 2015). The prerequisite is transparent performance goals; students then explore methods suited to their constraints. Although large-unit PE aspires to shift from teacher- to learner-centered instruction, “one-voice” teaching persists, with uniform methods imposed irrespective of differences. Under NLP, learners evaluate task demands and personal abilities within the environment, then select means to attain goals. In a basketball shooting unit, for example, the teacher articulates outcome goals; students explore routes to achieve them. Different learners will choose different techniques, revealing individual variability and capacity–task matching. The aim is to cultivate problem-solving in authentic settings and promote skill transfer. Self-organization broadens solution spaces and fosters adaptability—but always within *constraint-led* boundaries, not as unbounded freedom

5.Conclusion and suggestion

5.1.The Value of Nonlinear Pedagogy in Large-Unit Teaching

Nonlinear pedagogy conceptualizes students, teachers, the learning environment, and instructional tasks as components of a complex system characterized by nonlinearity and continuous change. In physical education, nonlinear pedagogy emphasizes perception–action coupling within complex environments and employs a constraint-led approach to foster students' self-organization. This process equips learners to adapt to changing conditions and promotes the development of exploratory and adaptive capacities. Applied to sport-specific skills, it strengthens student-centered learning, enhances skill transfer, and improves adaptability.

5.2 Interest-Driven Development of Practical Ability

Nonlinear pedagogy treats exploratory behavior as a fundamental right of learners. From the perspective of protecting students' natural tendencies and respecting individual interests, it grants freedom to explore personalized movement solutions, thereby satisfying intrinsic needs and activating autonomous motivation (Ye & Jia, 2023). Within this framework, the teacher–student relationship is dialogical rather than hierarchical, and learning is characterized by autonomy, exploration, and enjoyment. In tennis forehand instruction, compared with traditional methods that demand repetitive drills followed by a simple game, nonlinear pedagogy employs more flexible designs. Its core lies in setting open-ended goals (e.g., returning the ball into the opponent's court) rather than prescribing rigid technical frameworks. This shift reduces monotony, stimulates interest, and encourages diverse technical attempts. Importantly, teachers continue to impose task-specific constraints to guide effective outcomes. For example, when a student's ball trajectory was excessively high, the teacher constrained the racket face orientation to correct angle and ball quality; when topspin was lacking, net height was adjusted to foster understanding. Thus, teachers act as designers of representative contexts, and students achieve technical outcomes through exploration rather than rote repetition.

5.3 Promoting Skill Transfer through Exploratory Practice

Skill transfer, central to the "explore–adapt" model of ecological dynamics, entails adapting established movement patterns to new environmental constraints (Ye & Jia, 2024). The goal is to apply learned techniques to novel tasks or to use prior learning to guide new contexts. In this study, although students were required to achieve performance outcomes, their methods were not restricted. As a result, many adopted unconventional techniques to secure points in competition. Furthermore, interviews revealed that after mastering the tennis forehand, students reported improvement in table-tennis forehand strokes. The likely explanation is that while exploring tennis forehands, they internalized principles of spin production and net clearance, which they subsequently applied—often unconsciously—to table tennis. Thus, the experiment demonstrated that nonlinear pedagogy facilitates positive transfer of motor skills.

5.4 Enhancing Adaptive Capacity through Skill Transfer

Exploration and adaptation are ability-driven processes. Adaptation emerges when individuals detect and exploit meaningful environmental features to "find their own way" (Ingold, 2000). Accordingly, adaptive capacity depends on exploratory capacity. In this study, teachers periodically altered favorable conditions: implementing handicap scoring to challenge stronger players, reducing target zones to increase task difficulty, altering racket sizes to enhance precision, and involving spectators to simulate performance pressure. Under these constraints, experimental-group students consistently exhibited superior emotional regulation and composure during adverse situations compared with controls.Although control-group students often displayed faster shots and higher ball quality, experimental-group students leveraged classroom-acquired adaptability to recover from early deficits and secure victories. These results suggest that nonlinear pedagogy, by encouraging learners to actively mine skills from environmental interactions, significantly promotes adaptive competence.

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