

Application of Service Duel Approach to Improve High Secondary School Students' Badminton Backhand Serve Accuracy

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ABSTRACT

Low psychomotor skill levels in badminton backhand serves remain a persistent challenge in high school physical education due to monotonous, teacher-centered instructional approaches. This Classroom Action Research (CAR) investigated the effectiveness of the Service Duel Approach—a paired, game-based competitive framework—in improving backhand serve accuracy, technical understanding, and learning engagement among 24 ninth-grade students at High Secondary School YP PGRI 1 Makassar (selected via purposeful sampling). Guided by the Kemmis and McTaggart action research cycle, data were collected over two cycles using a validated zone-based psychomotor service test (content validity index CVI = 0.88, inter-rater reliability ICC = 0.91), a cognitive understanding test (KR-20 = 0.84), and a structured affective observation sheet. Baseline observations indicated severe deficit, with only 12.50% of participants achieving the Minimum Mastery Criteria (KKTP $\geq$ 80; M = 68.00). Following Cycle I interventions, mastery reached 41.67% (M = 74.50). With refined targeted corrective feedback, basic mechanical drills, and peer assessment in Cycle II, 100.00% of participants met the mastery threshold (M = 83.42). While the 100% completion rate reflects specific classroom success within the CAR framework, potential novelty effects and short evaluation windows represent acknowledged study boundaries. The findings demonstrate that structured gamified duels successfully optimize psychomotor coordination and motor learning.

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1. INTRODUCTION

Physical education, sports, and health (PJOK) serve as an essential pillar of secondary education, aimed at fostering psychomotor competence, physical literacy, and lifelong health behaviors among adolescents (Anwar et al., 2024; Irvan, 2024; Setyawan et al., 2022). Within the Indonesian physical education curriculum, racquet sports—particularly badminton—hold immensely high popularity and cultural

significance, driven by a rich history of national sporting achievements that continuously motivate high school students (Sutikno et al., 2025). Among the fundamental technical skill sets in badminton, the short backhand serve is universally recognized as a critical offensive and defensive element in competitive play (Carboch & Ďurčo, 2025). Precise serve execution—characterized by a low trajectory tight over the net landing in the opponent's front service box—directly controls rally initiation, restricts aggressive return shots, and establishes an immediate tactical advantage for the server (Lino et al., 2025).

Despite its strategic importance, mastering the backhand serve represents a persistent instructional hurdle in secondary school physical education settings (Heidorn, 2024). High school students routinely experience marked difficulties executing delicate fine motor movements, precise wrist deceleration, and subtle eye-hand coordination under live court conditions (Juniarisca et al., 2026; Wang et al., 2025). Motor skill acquisition literature highlights that backhand serve mechanics require a seamless, multidimensional integration of physical readiness (Skrzeba & Vogt, 2018), emotional self-regulation under competitive pressure (Duncan et al., 2017), and proper cognitive internalization of complex movement biomechanics (Abedanzadeh et al., 2022). Consequently, achieving consistent serve accuracy demands an instructional environment that addresses these interconnected domains simultaneously rather than in isolation.

However, conventional physical education paradigms in secondary schools remain predominantly teacher-centered, relying heavily on repetitive, isolated drill practice characterized by minimal tactical context, rigid movement reproduction, and limited dynamic feedback. This pedagogical rigidity frequently leads to learner boredom, diminished intrinsic motivation, and suboptimal skill acquisition and retention outcomes (Maksum et al., 2026). When motor skill execution is decoupled from authentic game scenarios, students fail to develop the perceptual-cognitive connections necessary to transfer mechanical movement patterns into effective tactical application during competitive match conditions (Crook et al., 2026).

To address these systemic pedagogical limitations, contemporary physical education researchers have increasingly advocated for game-based learning (GBL) models and modified small-sided game structures (Meilanisa et al., 2026; Qian & Clark, 2016). Recent international literature demonstrates that integrating game-based frameworks, tactical decision-making approaches, and structured peer competition significantly enhances motor performance, tactical intelligence, and intrinsic motivation compared to traditional, isolated skill drills (Harvey et al., 2018; Manninen et al., 2025). Grounded in Self-Determination Theory (Ryan & Deci, 2020), gamified learning environments effectively fulfill learners' basic psychological needs for autonomy, competence, and social relatedness, thereby fostering sustained engagement. Furthermore, core motor learning principles emphasize that long-term skill retention and transfer are optimized when practice conditions incorporate situational variability, dynamic feedback loops, and meaningful contextual interference (Anderson et al., 2019).

While a substantial body of literature supports the overarching efficacy of game-centered approaches in physical education (Breed et al., 2025; Gustian & Pranata, 2025; Syah, 2025), empirical research specifically evaluating paired, zone-based competitive serve frameworks within secondary school badminton instruction remains sparse. Most prior interventions focus either on unconstrained general match play—where serve repetitions are insufficient—or on isolated mechanical repetitions that lack realistic competitive pressure. This study addresses this distinct empirical gap by designing and evaluating the 'Service Duel Approach'—a structured, paired instructional framework combining point-zone scoring systems, peer observation protocols, and progressive competitive duels designed to simultaneously enhance backhand serve accuracy, tactical decision-making, and technical understanding.

Consequently, the primary objective of this Classroom Action Research (CAR) was to empirically evaluate the extent to which the Service Duel Approach improves badminton backhand serve learning outcomes across the psychomotor, cognitive, and affective domains among high school students. The central action hypothesis posits that systematically implementing the Service Duel Approach over iterative, cyclical action research phases will significantly increase individual student service accuracy and push classical learning mastery beyond the mandatory 80% institutional threshold.

2. METHOD

This study employed a Classroom Action Research (CAR) design following the cyclical model established by Kemmis et al. (2014), which integrates four continuous phases per cycle: planning, action implementation, systematic observation, and reflection. CAR was selected because it provides a rigorous, reflective framework for practitioner-researchers to diagnose instructional problems, implement targeted pedagogical interventions, and systematically evaluate learning improvements within natural classroom settings.

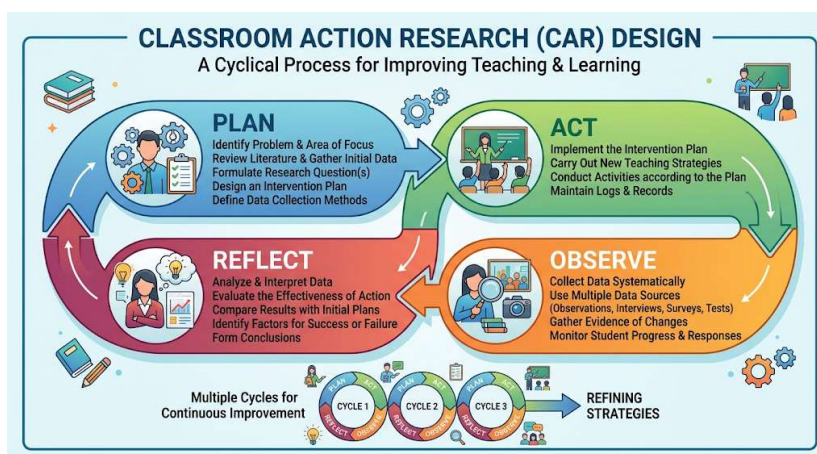


Figure 1. Classroom Action Research (CAR) Design

The research was conducted at High Secondary School YP PGRI 1 Makassar, Indonesia, during the 2025/2026 academic year. The study focused on a single intact

ninth-grade physical education class consisting of 24 students (14 males, 10 females; aged 14–15 years). A purposeful sampling technique was utilized, selecting this specific class due to documented baseline deficiencies in badminton service skills and low engagement during conventional physical education units. Because this study constitutes a localized action research intervention focused on a specific class unit, the 24 participating students represent the action subjects rather than a generalized population sample.

The action intervention was implemented across two cycles, each comprising two instructional meetings (90 minutes per session). Each cycle followed the structured four-stage CAR flow:

- **Planning:** Designing tailored lesson plans (RPP/Modul Ajar), establishing target service zone boundaries on courts, structuring paired student rotation brackets, and preparing domain assessment instruments.
- **Action Implementation:** Executing the Service Duel intervention. Students operated in pairs across court grids divided into specific scoring zones: Zone A (20–40 cm from short service line = 3 points), Zone B (41–80 cm = 2 points), Zone C (>80–396 cm = 1 point), and Out/Net Error (Zone D = 0 points). Pairs engaged in best-of-three duel matches (30 total points), alternating 10 serves per set. Cycle II incorporated refined action modifications, including 15-minute pre-duel technical mechanical drills, individualized corrective feedback, and structured peer assessment checklists.
- **Observation:** Concurrent systematic recording of psychomotor service execution scores, cognitive understanding tests, and affective engagement behaviors using standardized rubrics.
- **Reflection:** Collaborative analysis between the physical education teacher and observer to evaluate performance metrics against success criteria and identify required instructional adjustments for subsequent cycles.

To ensure methodological rigor, data were collected across three learning domains using validated assessment instruments:

- **Psychomotor Assessment:** A standardized 20-trial backhand serve performance test utilizing the zone scoring system (A=3, B=2, C=1, D=0). Content validity was established through expert judgment by two sports pedagogy professors and a senior badminton coach, yielding a Content Validity Index (CVI) of 0.88. Inter-rater reliability was evaluated across trial scoring, achieving an Intraclass Correlation Coefficient (ICC) of 0.91.
- **Cognitive Assessment:** A 5-item structured written test measuring student understanding of backhand serve grip mechanics, racket path, rules, and tactical shuttle placement. Internal consistency reliability was established using Kuder-Richardson 20 (KR-20 = 0.84).
- **Affective Assessment:** A structured behavioral observation rubric assessing sportsmanship, discipline, peer cooperation, and task perseverance during duels, evaluated using a 4-point Likert scale (Cronbach's alpha = 0.86).

Individual learning outcome scores across the three weighted domains (Psychomotor = 50%, Cognitive = 30%, Affective = 20%) were calculated using the standard percentage conversion formula: $\text{Final Score} = (\text{Earned Score} / \text{Maximum Score}) \times 100$. Student scores were evaluated against the institutional Learning Objective Achievement Criteria (Kriteria Ketercapaian Tujuan Pembelajaran / KKTP) threshold of 80. Classical learning mastery (P) was calculated as $P = (\text{Sum of Mastered Students} / \text{Total Students}) \times 100\%$. The action intervention was benchmarked against the institutional CAR success criterion: achieving classical learning mastery of $\geq 80\%$ with a class mean score ≥ 80.00 .

3. RESULTS AND DISCUSSION

Results

The implementation of the Service Duel Approach yielded progressive improvements in student backhand serve performance, cognitive understanding, and affective engagement across all research phases. Individual student scores across domains were consolidated into domain means and classical mastery rates to provide a clear analysis of learning trajectories.

Pre-Cycle Baseline Performance

Initial diagnostic observations conducted prior to the implementation of the instructional intervention revealed critical skill deficits in students' performance under conventional teaching paradigms. Quantitative assessment of the 24 participating students demonstrated an alarming baseline mastery rate: only three students (12.50%) successfully attained the targeted criterion-referenced minimum mastery benchmark (KKTP ≥ 80). Conversely, the vast majority—comprising 21 students (87.50%)—failed to meet the mandated performance threshold, resulting in a substandard class mean score of 68.00. This pronounced skew toward lower proficiency levels underscores the empirical inadequacy of traditional pedagogical approaches in fostering functional movement patterns, necessitating a structured Action Research intervention to bridge the observed psychomotor gap.

Detailed micro-diagnostic evaluations further clarified the underlying biomechanical and tactical execution errors driving these systemic failures. Students exhibited persistent technical shortcomings, primarily characterized by inconsistent backhand grip transitions and deficient wrist-flick mechanics during stroke execution. These kinematic errors directly compromised shuttle trajectory control, causing shots to consistently fall out of bounds in deep court areas (Zone C) or fail to clear the net entirely (Zone D). The interplay between faulty hand-eye coordination and improper force application highlights a fundamental gap in spatial awareness and motor-skill acquisition, confirming that targeted pedagogical modifications are imperative to refine execution dynamics and elevate overall student achievement.

Cycle I Performance and Refinement Needs

The implementation of the Service Duel Approach during Cycle I integrated structured paired duels and point-zone scoring mechanisms to optimize active

engagement and task-oriented practice. Initial outcomes from Meeting I demonstrated a marginal upward trajectory in performance, yielding a class mean score of 68.88 with only three students (12.50%) reaching the targeted mastery benchmark. However, following targeted pedagogical refinements—specifically tactical debriefing sessions and strategic partner adjustments prior to Meeting II—student execution improved substantially. By the conclusion of Meeting II, ten students (41.67%) successfully attained mastery, elevating the overall Cycle I composite mean score to 74.50. Granular domain analysis revealed balanced growth across sub-variables, with psychomotor performance recording the highest mean ($M = 75.83$), followed closely by cognitive ($M = 73.92$) and affective domains ($M = 73.75$).

While the gamified, competitive dynamics of the duel format visibly heightened learner motivation and task commitment, the aggregate classical mastery rate of 41.67% remained markedly below the institutional target threshold of 80.00%. Diagnostic reflection on Cycle I video footage and observational data revealed that persistent biomechanical errors continued to impede optimal skill acquisition. Specifically, students struggled with racket face angle control at the precise point of impact, which directly compromised shuttle trajectory consistency and placement accuracy. These physical execution bottlenecks, combined with inconsistent spatial control during high-pressure rallies, indicated that while the Service Duel framework successfully enhanced affective engagement, structural modifications to technical feedback and task progression are strictly required for Cycle II.

Table 1. Backhand Serve Performance Across Learning Domains and Research Phases

Phase / Meeting	Psychomotor (M)	Cognitive (M)	Affective (M)	Final Score (M)	Mastered (n/%)	Non-Mastered (n/%)
Pre-Cycle (Baseline)	67.50	68.33	68.17	68.00	3 (12.50%)	21 (87.50%)
Cycle I - Meeting I	69.17	68.58	68.13	68.88	3 (12.50%)	21 (87.50%)
Cycle I - Meeting II	75.83	73.92	73.75	74.50	10 (41.67%)	14 (58.33%)
Cycle II - Meeting I	80.25	79.17	80.83	80.08	13 (54.17%)	11 (45.83%)
Cycle II - Meeting II	83.58	82.58	84.17	83.42	24 (100.00%)	0 (0.00%)

Cycle II Performance and Action Achievement

To address the biomechanical and tactical execution bottlenecks identified during Cycle I, Cycle II introduced three targeted pedagogical refinements designed to enhance technical precision and self-regulated learning: (1) a 15-minute dedicated pre-duel micro-drilling module emphasizing thumb placement ergonomics and short-swing deceleration mechanics; (2) real-time, personalized kinematic feedback delivered immediately during duel executions; and (3) structured peer-assessment diagnostic rubrics. The visual, kinesthetic, and reflective scaffolds yielded significant immediate improvements during Cycle II Meeting I, where classical mastery rose to 54.17% ($n =$

13) with a class mean of 80.08. By Cycle II Meeting II, the intervention achieved maximum efficacy: all 24 participating students (100.00%) successfully met or exceeded the established mastery threshold ($KKTP \geq 80$). This complete performance transformation resulted in an overall Cycle II aggregate mean score of 83.42, characterized by balanced high-level achievement across the psychomotor ($M = 83.58$), cognitive ($M = 82.58$), and affective ($M = 84.17$) domains.

The progressive trajectory across intervention phases underscores the synergistic effect of pairing gamified practice with explicit technical scaffolding and peer feedback mechanisms. As motor execution stabilized, cognitive clarity and affective self-efficacy demonstrated concurrent linear growth, reflecting full operationalization of the refined instructional framework. To illustrate these empirical gains systematically, Table 1 provides a consolidated comparison of student learning outcome progressions across the pre-cycle, Cycle I, and Cycle II phases. Furthermore, to provide a granular view of performance redistribution across proficiency levels, Table 2 details the dynamic shift in student achievement categories from baseline diagnostic conditions to final intervention completion.

Table 2. Distribution of Student Learning Outcomes by Performance Category

Score Range	Category	Pre-Cycle n (%)	Cycle I n (%)	Cycle II n (%)	Mastery Status
86 – 100	Very Good	0 (0.00%)	0 (0.00%)	8 (33.33%)	Mastered
80 – 85	Good	3 (12.50%)	10 (41.67%)	16 (66.67%)	Mastered
70 – 79	Fair	9 (37.50%)	6 (25.00%)	0 (0.00%)	Not Mastered
< 70	Poor	12 (50.00%)	8 (33.33%)	0 (0.00%)	Not Mastered

Discussion

The findings of this study demonstrate that the implementation of the Service Duel Approach successfully enhanced badminton backhand serve accuracy, technical understanding, and affective engagement among high school students, driving a progressive transformation from a baseline classical mastery rate of 12.50% to 100.00% by the end of Cycle II. These empirical outcomes strongly support the initial research hypothesis and reinforce a growing body of pedagogical literature highlighting the instructional efficacy of gamified small-sided learning models in physical education contexts (Ezeddine et al., 2025; Harvey et al., 2018; Perdima et al., 2026; Pratama et al., 2026). By structuring competitive mechanics within localized spatial constraints, the intervention created an optimal learning environment that effectively bridged initial skill deficits and elevated student achievement across psychomotor, cognitive, and affective domains.

From a motor learning perspective, the dramatic performance gains observed between Cycle I (41.67%) and Cycle II (100.00%) can be systematically explained through established motor skill acquisition frameworks. Executing a low badminton backhand serve demands highly refined fine-motor control, precise wrist deceleration, and constant contact point stability at racket-shuttle impact. In conventional drill environments, repetitive hitting without contextual targets frequently fails to provide immediate kinematic feedback, thereby reinforcing persistent mechanical errors. The

Service Duel Approach directly mitigated this diagnostic limitation by establishing high visual clarity through designated court zone target boundaries (Zones A, B, and C). This spatial scoring architecture provided immediate task-intrinsic feedback, allowing learners to visually assess trajectory errors and autonomously adjust their wrist angles and swing amplitudes on subsequent repetitions.

Furthermore, the psychological dynamics inherent in paired competitive duels played a pivotal role in augmenting student motivation and active participation throughout the intervention. Grounded in Self-Determination Theory (Ryan & Deci, 2020), the Service Duel structure systematically satisfied three core psychological needs: autonomy, through student selection of targeted serve strategies; competence, through the acquisition of immediate zone-based points; and relatedness, through active peer duels and mutual scoring responsibilities. Rather than inducing performance anxiety, the recreational paired duel format cultivated positive competitive excitement, which significantly sustained task perseverance and active behavioral engagement (Zhou, 2024).

The deliberate integration of peer-assessment checklists during Cycle II further solidified cognitive understanding and self-regulatory competence among learners. By actively observing, evaluating, and providing structured feedback on their peers' movement mechanics, students were forced to internalize criteria for technical execution. This reflective process effectively deepened their internal mental models of proper backhand serve mechanics, accelerating the transition from cognitive movement formulation to autonomous motor execution. Consequently, the combination of real-time peer feedback and explicit instructional scaffolds ensured that technical adjustments were continuously reinforced throughout practice trials.

These findings strongly align with prior research conducted by Li et al. (2024) and Mahedero et al. (2021), who reported that small-sided competitive games and structural game modifications significantly improve basic skill mastery in secondary school physical education. However, the present study extends the existing literature by proving that integrating zone-based scoring with structured peer feedback loops accelerates psychomotor skill acquisition more rapidly than gamified competition alone. Specifically, the pre-duel micro-mechanical drills introduced in Cycle II provided essential biomechanical stabilization—particularly regarding thumb placement and swing deceleration—effectively bridging the operational gap between isolated movement patterns and dynamic match applications.

Despite these positive empirical outcomes, several methodological limitations must be acknowledged to contextualize the study's scope. First, given the Classroom Action Research (CAR) design executed within a single class of 24 participants, the generalizability of these findings to broader populations requires careful contextual alignment. Second, while the 100.00% mastery rate represents complete success relative to the localized institutional criterion-referenced benchmark ($KKTP \geq 80$), potential novelty effects (the Hawthorne effect) associated with newly introduced scoring equipment and observer presence may have artificially heightened student effort. Third, motor skill acquisition was evaluated over a condensed instructional timeframe without

assessing long-term retention. To validate the structural durability of these motor skills, future research should utilize randomized controlled trials (RCT), incorporate larger sample sizes across diverse educational institutions, and employ delayed retention testing.

4. CONCLUSION

This classroom action research demonstrates that the service duel approach is a highly effective pedagogical framework for improving badminton backhand serve learning outcomes in secondary school physical education. By replacing monotonous conventional drills with paired, zone-based competitive duels, the intervention successfully transformed student performance across psychomotor, cognitive, and affective domains. Student mastery increased from a baseline of 12.50% ($M = 68.00$) to 41.67% in Cycle I ($M = 74.50$), culminating in 100.00% classical mastery in Cycle II ($M = 83.42$), thereby fully satisfying institutional performance benchmarks.

The theoretical contribution of this study lies in illustrating how gamified paired competition, when synergistically combined with immediate zone-based task-intrinsic feedback and peer observation dynamics, optimizes both motor skill acquisition and intrinsic motivation within secondary physical education settings. Practically, the Service Duel Approach offers physical educators an adaptable, low-cost instructional framework that effectively transforms repetitive technical practice into an engaging, learner-centered experience. Moving forward, physical education practitioners are advised to adapt these zone-based duel formats to refine other closed-skill racquet techniques (e.g., forehand serves, drop shots) and broader Net/Wall games, while curriculum developers should formally integrate gamified small-sided competition frameworks into secondary teaching modules to enhance active student engagement. Furthermore, future research should employ quasi-experimental or randomized controlled trial (RCT) designs to rigorously evaluate the Service Duel Approach against alternative game-centered paradigms—such as Teaching Games for Understanding (TGfU)—across larger sample sizes while integrating long-term skill retention measures.

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