

RESEARCH ARTICLE

Enhancing Badminton Playing Skills Using Agility Training and Reaction-Time Training

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ABSTRACT

Badminton playing skills require the integration of agility, coordination, perceptual-cognitive processing, and precise motor control to execute effective movement and stroke performance. This study investigated the comparative effectiveness of agility training and reaction-time training in enhancing the badminton playing skills of Grade 10 students in a public secondary school. Employing a quasi-experimental pretest-posttest design with two non-equivalent groups, 87 participants completed an eight-week intervention. The agility group performed structured drills (ladder footwork, T-drill, and shadow footwork), while the reaction-time group performed reaction activities (Random Shuttle Drop, Fast-Flick Reaction Drill, and Hand Clap Reaction Game). Performance was assessed using the Lockhart and McPherson Badminton Skill Test and a standardized rubric evaluating footwork and court movement, stroke accuracy, and control. Descriptive results indicated that both groups improved from *Fair* in the pretest to *Very Good* in the posttest. Paired-sample *t*-tests confirmed significant within-group improvements across all skill components. A repeated-measures multivariate analysis confirmed a significant overall within-group improvement for each program. MANCOVA revealed that the agility training group achieved significantly higher posttest scores across all performance components, indicating higher overall effectiveness. Grounded in Dynamic Systems Theory and Information Processing Theory, the findings highlight the roles of movement adaptability and perceptual-cognitive processing in the acquisition of badminton skills. The study provides empirical evidence that agility-focused training yields stronger technical performance outcomes than reaction-time training in school-based badminton programs. These results support the integration of agility-centered modules and combined skill-training approaches within Physical Education curricula and offer a basis for developing scalable, evidence-based badminton instruction in Philippine secondary schools.

KEYWORDS agility training, reaction-time training, badminton skills, Dynamic Systems Theory, Information Processing Theory, quasi-experimental design

INTRODUCTION

Badminton is a high-intensity racket sport that requires technical precision, rapid court movement, perceptual responsiveness, and effective decision-making. Core performance indicators such as stroke accuracy, footwork speed, court movement, and control are essential for successful play, particularly among developing learners in school-based Physical Education settings (Endrawan *et al.*, 2024; Kızılet, 2024; Putri *et al.*, 2021). International studies have shown that structured badminton-related training can improve technical and motor performance. For instance, Farrel *et al.* (2023) found that students with stronger basic badminton skills performed better across game situations, while Zhang (2020) emphasized the role of biomechanical accuracy in maintaining effective forehand smash performance. Similarly, visual reaction-time training has been associated with improved cognitive responsiveness and gameplay performance among young racket sport athletes (Kızılet, 2024).

Recent evidence further suggests that agility and reaction-time interventions are promising approaches for improving badminton performance. Ghorpade *et al.* (2024) reported that backward treadmill walking combined with regular training improved balance, core stability, agility, and reaction time among badminton players. Likewise, Kuo *et al.* (2020) demonstrated that a low-cost visual reaction system, when paired with a footwork program, enhanced agility and reaction time in badminton training. Agility training supports quick directional changes, balance, and efficient court coverage, while reaction-time training strengthens players' ability to respond rapidly to shuttle movement and opponent cues (Chandra *et al.*, 2023; Kızılet, 2024). These findings indicate that both physical and perceptual-cognitive training may contribute to the development of badminton playing skills.

In the Philippine school context, badminton remains an important component of Physical Education and school sports participation. Physical Education is compulsory in basic education and promotes physical activity, healthy living, and sport-based skill development, with badminton included among commonly implemented activities (Gutierrez *et al.*, 2023). Badminton also continues to be practiced in inter-school competitions and national sporting events such as the Palarong Pambansa, which gathered more than 15,000 students in 2025 (Clavano, 2025). Local and regional studies have also shown that structured practice improves badminton performance. Sayefuddin and Suhadi (2023) found that practice distribution influenced short-service accuracy, while Soriano and Dolendo (2024) emphasized the relevance of strength, conditioning, training exposure, and experience in badminton athletes' skill competency.

Despite these developments, limited empirical evidence has directly compared agility training and reaction-time training within the same school-based badminton population. Existing studies have generally examined these interventions separately or in athlete-centered contexts, leaving a gap in evidence concerning their relative effectiveness among adolescent learners in regular Physical Education settings. This gap is important because school-based interventions must be practical, low-cost, developmentally appropriate, and feasible within existing class schedules. Thus, there is a need to determine which training approach more effectively improves badminton playing skills when implemented under authentic school conditions.

To address this gap, the present study examined the effects of agility training and reaction-time training on the badminton playing skills of Grade 10 students in a public secondary school in Malaybalay City. Specifically, the study focused on three performance components: footwork and court movement, stroke accuracy, and control. The intervention was anchored on the assumption that agility training enhances biomechanical organization and movement adaptability, while reaction-time training improves perceptual

processing and rapid motor response, consistent with Dynamic Systems Theory and Information Processing Theory (Atkinson & Shiffrin, 1968; Thelen & Smith, 1994).

The study contributes to evidence-based Physical Education by identifying practical training strategies that may improve students' badminton performance and physical literacy. Its findings may guide PE teachers, coaches, curriculum developers, and school sports coordinators in designing structured, skill-specific, and context-responsive badminton training activities. In doing so, the study also supports broader educational and health goals by promoting active participation, movement competence, and quality school-based sport instruction aligned with SDG 3 on Good Health and Well-being and SDG 4 on Quality Education.

Statement of the Problem

The general objective of this study was to enhance badminton playing skills using agility training and reaction-time training. In line with this, this study aimed to answer the following research questions:

1. What is the participants' badminton playing skill level of the two groups before and after the interventions?
2. Do the two groups of participants' badminton playing skills significantly differ before and after the interventions?
3. Which of the interventions is more effective in enhancing badminton playing skills?

Hypotheses

Based on the research questions, the following null hypotheses were formulated to be tested at $\alpha = 0.05$ level of significance:

H₀₁: There is no significant difference in the badminton playing skill level of the two groups before and after the interventions.

H₀₂: None of the interventions is more effective in enhancing badminton playing skills.

MATERIALS AND METHODS

This study adopted a quasi-experimental pretest-posttest non-equivalent groups design to investigate the effectiveness of agility training and reaction-time training in enhancing badminton playing skills among secondary school learners. A quasi-experimental approach was deemed appropriate because the research was conducted in an authentic classroom environment, where intact class sections could not be randomly reassigned to treatment conditions. Such designs support meaningful causal interpretation in educational contexts, particularly when researchers aim to examine intervention effects while working within institutional constraints (Campbell & Stanley, 1957; Shadish *et al.*, 2002). Consistent with the literature on applied school-based experimental research, the use of non-randomized but naturally occurring groups provides a feasible structure for delivering controlled interventions while retaining ecological validity (Hastjarjo, 2019; Ouanhlee, 2023). Two intact Grade 10 classes were assigned to the agility and reaction-time training programs, respectively, while a third class was designated for pilot testing procedures, instrument refinement, and clarification of scoring protocols.

Pretest and posttest measures enabled the examination of changes across time while helping to address initial group differences through baseline assessment, an approach endorsed in methodological

studies emphasizing internal validity in quasi-experiments (Amo-Asante & Bonyah, 2023; Purba *et al.*, 2023; Pamungkas, 2022).

The participants of the study were 87 Grade 10 students aged 15 to 16 years from a public secondary school in Malaybalay City. These students were drawn from three intact class sections taught by the researcher during the 2025–2026 school year. Participation was limited to students who were medically cleared through the Physical Activity Readiness Questionnaire, consistently present in Physical Education classes, and able to submit both parental informed consent and personal assent. Students who were undergoing therapy, had musculoskeletal limitations, frequently missed classes, or declined participation were excluded. Attrition was expected, and only students who completed both the pretest and posttest were included in the final analysis, though all withdrawals were documented for transparency. The final sample comprised 87 students who completed both assessments—44 in the agility training group and 43 in the reaction-time training group. The participants were drawn from three intact class sections that were combined and then allocated to the two intervention groups. This participant selection process aligns with recommended practices in Philippine quasi-experimental Physical Education research, which often uses intact classes due to practical and ethical considerations (Hofeliña, 2025; Perfecto, 2025).

To assess badminton skill performance, the study employed the Lockhart and McPherson Badminton Skill Test, a validated, widely used field-based performance measure. This test requires participants to perform repeated shuttle hits against a standardized wall target within a fixed time interval, generating quantifiable indicators of accuracy, consistency, and technical control (Savitribai Phule Pune University, 2015). The instrument demonstrates high test–retest reliability ($r = .90$) and acceptable construct validity coefficients, making it suitable for middle adolescence and school-level performance assessment. In addition to the standardized test, the researcher developed a rating scale to evaluate footwork and court movement, stroke accuracy, and shuttle control. One trained Physical Education instructor assisted the researcher in observing and scoring the pretest and posttest to improve objectivity and consistency, with scoring procedures refined through a pilot test conducted prior to the intervention. Each performance dimension was assessed through a 5-point rating scale, and a composite score combining the three components provided a holistic indicator of each participant's badminton playing skill.

Before formal data collection, ethical clearance was obtained from the Lourdes College Research Ethics Committee, and the Schools Division Office of Malaybalay City granted administrative permission. Students and parents attended an orientation explaining the study's objectives, procedures, potential risks, and the voluntary nature of participation. In accordance with the Belmont Principles—Respect for Persons, Beneficence, and Justice—the researcher ensured that participants' rights were upheld throughout the process.

Coded identifiers replaced student names in all records to protect confidentiality; data were stored securely in password-protected, locked systems; and all files will be retained for 3 years before permanent disposal in accordance with the Data Privacy Act of 2012. A risk management protocol was implemented to address potential injuries during training sessions, with first aid and referrals made available as needed.

The intervention lasted eight weeks and was implemented twice weekly during scheduled MAPEH classes. The agility training program consisted of progressive drills—ladder footwork drills, the T-drill (speed and directional change), and shadow footwork drills—aimed at improving speed, balance, and coordinated court movement. In contrast, the reaction-time training program emphasized rapid perceptual-cognitive responses through the Random Shuttle Drop drill, the Fast-Flick Reaction drill, and the Hand Clap Reaction game. Both interventions followed a structured format comprising a warm-up, core drills, and a cool-down,

with intensity gradually increasing from low to moderate-high over the course of the program. The researcher monitored all sessions to ensure fidelity of implementation and participant safety.

Data analysis was conducted using SPSS, with statistical significance set at $p < .05$ for all analyses. Each research question was matched to a specific test. For Research Question 1, descriptive statistics (frequencies, percentages, means, and standard deviations) summarized pretest and posttest performance for each skill component. For Research Question 2 (within-group change), paired-samples t-tests were performed for each skill component within each intervention condition, and a repeated-measures multivariate analysis of variance (RM-MANOVA) examined the overall multivariate change across footwork and court movement, stroke accuracy, and control within each group. For Research Question 3 (between-group comparison), a multivariate analysis of covariance (MANCOVA) compared the two training programs' posttest performance across the three components simultaneously, using the corresponding pretest scores as covariates. Because the groups were intact and non-randomized, initial baseline differences were controlled statistically through this covariate adjustment rather than through random assignment.

RESULTS

Problem 1. What is the participants' badminton playing skill level of the two groups before and after the interventions?

Table 1 presents the frequency, percentage, and mean distribution of the badminton playing skill levels of the agility training group and the reaction-time training group before and after the interventions.

Table 1. Descriptive Statistics of Badminton Playing Skill Considering All Components Before and After the Interventions

Range	Interpretation	Agility Training				Reaction-Time Training			
		Pretest		Posttest		Pretest		Posttest	
		f	%	f	%	f	%	f	%
4.51 - 5.00	Outstanding	0	0	5	11.36	0	0.00	1	2.33
3.51 - 4.50	Very Good	0	0.0	36	81.82	0	0.00	26	60.47
2.51 - 3.50	Good	0	0.0	2	4.55	0	0.00	13	30.23
1.51 - 2.50	Fair	35	79.5	1	2.27	40	93.02	3	6.98
1.00 - 1.50	Poor	9	20.5	0	0.00	3	6.98	0	0.00
TOTAL		44	100	44	100	43	100	43	100
Mean		1.97		4.22		2.06		3.84	
Interpretation		Fair		Very Good		Fair		Very Good	
SD		0.29		0.46		0.25		0.60	

Here, the agility training group had most of its participants classified as Fair (79.5%) and Poor (20.5%) during the pretest, resulting in a mean of 1.97. After the intervention, the distribution shifted, with the majority now falling under the Very Good category (81.82%), followed by a small proportion in Outstanding (11.36%) and Good (4.55%), producing a mean of 4.22. Similarly, the reaction-time training group began with predominantly Fair skill levels (93.02%) and a smaller percentage in Poor (6.98%), corresponding to a mean of 2.06. In the posttest, most participants moved into the Very Good category (60.47%), followed by Good (30.23%), and a few in Outstanding (2.33%), resulting in a mean of 3.84. The descriptive results indicate that participants in the Poor and Fair categories demonstrated limited execution of essential badminton components, including footwork, control, coordination, and timely responses. These ratings reflected

minimal mastery of the required movement patterns. In contrast, those categorized as Very Good or Outstanding exhibited more consistent and efficient performance of badminton skills, characterized by better control, coordination, and the ability to carry out movement sequences with greater accuracy and stability.

Problem 2. Do the two groups of participants' badminton playing skills significantly differ before and after the interventions?

Ho: There is no significant difference in the badminton playing skill level of the two groups before and after the interventions.

Table 2 presents the paired-samples t-test and repeated-measures multivariate (RM-MANOVA) results comparing the pretest and posttest badminton-playing skill scores of students exposed to the agility training intervention.

Table 2. Paired-Samples t-test and Repeated-Measures Multivariate Analysis of Variance Between Pretest and Posttest Badminton Playing Skill Scores among Students Exposed to Agility Training

Badminton Playing Skill	Pretest			Posttest			t(43)	p
	M	Int	SD	M	Int	SD		
Footwork and Court Movement	2.09	F	0.57	4.24	VG	0.52	-21.844*	< .001
Stroke Accuracy	1.92	F	0.54	4.08	VG	0.65	-15.677*	< .001
Control	2.01	F	0.42	4.18	VG	0.50	-22.917*	< .001

Multivariate Analysis

Wilks' $\Lambda = 0.049$ $F(1,43) = 264.103^*$ $p < .001$ Partial $\eta^2 = .951$

Note. M = mean, Int = Interpretation SD = standard deviation, Partial η^2 = effect size. Effect size interpretation: 0.01 to 0.05 is small, 0.06 to 0.13 is medium, above or equal 0.14 is large, Legend: 4.51 – 5.00 O = Outstanding, 3.51 – 4.50 VG = Very Good, 2.51 – 3.50 G = Good, 1.51 – 2.50 F = Fair, 1.00 – 1.50 P = Poor. *Significant at 0.05 two-tailed alpha level.

The agility group's pretest scores were consistently in the Fair range across all components—footwork and court movement ($M = 2.09$), stroke accuracy ($M = 1.92$), and control ($M = 2.01$). In the posttest, all components shifted to the Very Good range, with mean scores of 4.24, 4.08, and 4.18, respectively. The paired-sample t-tests indicated statistically significant differences between pretest and posttest scores across all components ($p < .001$), suggesting that the students' badminton playing skills were significantly higher after the intervention.

Table 3 presents the paired-samples t-test and repeated-measures multivariate analysis of variance between pretest and posttest badminton playing skill scores among students exposed to reaction-time training.

Table 3. Paired-Samples t-test and Repeated-Measures Multivariate Analysis of Variance Between Pretest and Posttest Badminton Playing Skill Scores among Students Exposed to Reaction-Time Training

Badminton Playing Skill	Pretest			Posttest			t(42)	p
	M	Int	SD	M	Int	SD		
Footwork and Court Movement	2.08	F	0.52	3.86	VG	0.66	-14.003*	< .001
Stroke Accuracy	2.01	F	0.53	3.65	VG	0.62	-14.174*	< .001
Control	2.01	F	0.49	3.91	VG	0.63	-16.347*	< .001

Multivariate Analysis

Wilks' $\Lambda = 0.098$ $F(1,42) = 122.915^*$ $p < .001$ Partial $\eta^2 = 0.902$

Note. M = mean, Int = Interpretation SD = standard deviation, Partial η^2 = effect size. Effect size interpretation: 0.01 to 0.05 is small, 0.06 to 0.13 is medium, above or equal 0.14 is large, Legend: 4.51 – 5.00 O = Outstanding, 3.51 – 4.50 VG = Very Good, 2.51 – 3.50 G = Good, 1.51 – 2.50 F = Fair, 1.00 – 1.50 P = Poor. *Significant at 0.05 two-tailed alpha level.

In Table 3, the reaction-time training group began with pretest scores in the Fair range across all components—footwork and court movement (M = 2.08), stroke accuracy (M = 2.01), and control (M = 2.01). In the posttest, the scores in all components shifted to the Very Good range, with mean scores of 3.86, 3.65, and 3.91, respectively. The paired-sample t-tests showed statistically significant differences between pretest and posttest scores for all three components ($p < .001$), indicating that students demonstrated significantly higher badminton playing skill levels following the intervention.

Taken together, the findings from Tables 2 and 3 demonstrate that both agility training and reaction-time training produced statistically significant improvements in badminton playing skills from pretest to posttest across all measured components. Participants in both groups progressed from Fair baseline performance to Very Good post-intervention performance in footwork and court movement, stroke accuracy, and control, indicating that each intervention was effective in substantially enhancing badminton skill proficiency. The consistently significant paired-sample t-test results (all $p < .001$) confirm that the observed gains were not due to chance, while the RM-MANOVA results further strengthen this interpretation by showing significant overall multivariate changes for both the agility training group (Wilks' $\Lambda = 0.049$, Partial $\eta^2 = .951$) and the reaction-time training group (Wilks' $\Lambda = 0.098$, Partial $\eta^2 = .902$). These exceptionally large effect sizes suggest that both interventions had powerful practical and statistical impacts on learners' badminton performance, with agility training demonstrating a slightly stronger combined effect. Therefore, based on the significant within-group improvements observed in both intervention conditions, H_{01} is rejected. The hypothesis stated that there is no significant difference in the badminton playing skill level of the two groups before and after the interventions. This means that exposure to either agility training or reaction-time training significantly improved participants' badminton playing skills, affirming that structured skill-based training interventions are effective approaches for enhancing school-based badminton performance.

Problem 3. Which of the interventions is more effective in enhancing badminton playing skills?

Ho₂: None of the interventions is more effective in enhancing badminton playing skills.

Table 4 presents the summary of the Multivariate Analysis of Covariance (MANCOVA) for posttest scores with pretest scores as covariates.

Table 4. Multivariate Analysis of Covariance (MANCOVA) Summary Table for Posttest Scores with Pretest Scores as Covariates

Badminton Playing Skill	Agility Training			Reaction-Time Training			F(1,84)	p
	M	Int	SD	M	Int	SD		
Footwork and Court Movement	4.24	VG	0.52	3.86	VG	0.66	8.854*	0.004
Stroke Accuracy	4.08	VG	0.65	3.65	VG	0.62	9.590*	0.003
Control	4.18	VG	0.50	3.91	VG	0.63	5.119*	0.026
Multivariate Analysis								
Wilks' $\Lambda = 0.874$			F(5,75) = 3.834	p = .013	Partial $\eta^2 = 0.126$			

Note. M = mean, Int = Interpretation SD = standard deviation, Partial η^2 = effect size. Effect size interpretation: 0.01 to 0.05 is small, 0.06 to 0.13 is medium, above or equal 0.14 is large, Legend: 4.51 – 5.00 O = Outstanding, 3.51 – 4.50 VG = Very Good, 2.51 – 3.50 G = Good, 1.51 – 2.50 F = Fair, 1.00 – 1.50 P = Poor. *Significant at 0.05 two-tailed alpha level.

Results show that both groups obtained posttest means interpreted as Very Good across all components; however, the agility training group recorded slightly higher mean scores in footwork and court movement ($M = 4.24$), stroke accuracy ($M = 4.08$), and control ($M = 4.18$) compared to the reaction-time training group, which obtained means of 3.86, 3.65, and 3.91 respectively. The component-level F-values indicate statistically significant differences between the two groups across footwork ($F = 8.854$, $p = .004$), stroke accuracy ($F = 9.590$, $p = .003$), and control ($F = 5.119$, $p = .026$). The multivariate test further supports these findings, showing a significant overall group effect after adjusting for pretest scores (Wilks' $\Lambda = 0.874$, $p = .013$), with a medium effect size (Partial $\eta^2 = .126$).

DISCUSSION

Both agility training and reaction-time training significantly improved the badminton playing skills of Grade 10 students, demonstrating that structured school-based interventions can meaningfully enhance footwork and court movement, stroke accuracy, and control. Prior to the intervention, both groups were predominantly classified within the Fair range, indicating limited technical execution and inconsistent movement performance. Following the eight-week training period, both groups progressed to the Very Good range across all components, suggesting that targeted physical and perceptual training can substantially strengthen badminton skill development among adolescent learners. This finding aligns with broader badminton and physical education research emphasizing that repeated, structured, and progressive practice enhances movement efficiency, technical precision, and skill mastery (Farrel *et al.*, 2023; Duncan *et al.*, 2023). The substantial movement from lower to higher performance classifications further suggests that school-based badminton learners benefit from intervention designs that systematically target both biomechanical and cognitive dimensions of performance.

The significant improvements observed in the agility training group particularly highlight the importance of movement adaptability, speed, and coordinated directional control in badminton skill acquisition. Agility training participants demonstrated marked gains in footwork and court movement, stroke accuracy, and control, with the multivariate findings indicating an exceptionally large effect size. These outcomes support previous evidence that agility-oriented drills such as ladder footwork, directional cone drills, and shadow exercises enhance dynamic balance, speed, and efficient court coverage (Chandra *et al.*, 2023; Kurniawan *et al.*, 2024; Septyani *et al.*, 2024). Because badminton requires rapid directional changes and stable body positioning to execute strokes effectively, agility-focused activities likely strengthened participants' ability to organize movement patterns more efficiently. From the perspective of Dynamic Systems Theory (Thelen & Smith, 1994), this suggests that repeated exposure to structured movement constraints enabled learners to self-organize more functional and adaptive motor solutions, thereby improving technical badminton execution.

Similarly, the reaction-time training group also demonstrated statistically significant improvements, reinforcing the role of perceptual-cognitive processing in badminton performance. Reaction-based drills improved all measured components, suggesting that faster sensory recognition and motor response contributed to better skill execution. These findings are consistent with studies emphasizing the value of visual and cognitive responsiveness in racket sports, where players must rapidly interpret environmental stimuli and produce coordinated motor actions (Kızılet *et al.*, 2024; Kuo *et al.*, 2020). Information Processing

Theory (Atkinson & Shiffrin, 1968) provides a useful framework for interpreting these results, as repeated reaction exercises may have enhanced the speed and efficiency of stimulus identification, decision-making, and motor output. In badminton contexts, this likely translated into quicker responses to shuttle trajectory, improved timing, and more effective court positioning.

Although both interventions were effective, agility training emerged as the more effective approach overall, producing significantly higher posttest scores across all badminton skill components. This suggests that while reaction-time training strengthens perceptual responsiveness, agility training may offer broader performance benefits because it more directly integrates movement mechanics with sport-specific execution. Badminton skill performance depends not only on recognizing stimuli quickly but also on physically repositioning the body efficiently to execute technically sound shots. Therefore, agility drills may have provided participants with a stronger foundation for combining speed, balance, and technical precision. This finding supports prior literature indicating that physical capacities such as agility and coordinated movement are central predictors of badminton performance, particularly among developing athletes (Wong *et al.*, 2019; Guo *et al.*, 2021).

The comparative superiority of agility training also carries important pedagogical implications for Physical Education instruction. In many school contexts, PE programs operate under limited time, equipment, and instructional resources; thus, interventions that maximize skill development efficiently are especially valuable. Agility drills such as ladder exercises, shadow footwork, and directional movement sequences are relatively low-cost, scalable, and practical for class implementation, making them highly suitable for curriculum integration. While reaction-time training remains beneficial, the stronger gains associated with agility suggest that PE teachers may prioritize movement-based skill modules when aiming to improve foundational badminton competence. This supports calls for evidence-based instructional design that aligns skill development with sport-specific performance demands (Gutierrez *et al.*, 2023).

With these, the findings demonstrate that badminton skill enhancement in school settings is best supported through structured interventions that integrate both motor and perceptual development, with agility training providing the strongest independent effect. The study contributes to school-based sports pedagogy by offering empirical evidence that targeted intervention design can significantly improve badminton performance among adolescent learners. More broadly, these results reinforce the value of applying theory-driven and context-responsive training strategies in Physical Education, where the goal extends beyond participation to measurable skill competence. Future research may further explore hybrid models combining agility and reaction-time training to determine whether integrated interventions can produce even greater improvements in badminton playing skills across diverse learner populations.

CONCLUSION

This study set out to determine the effectiveness of agility and reaction-time training in enhancing the badminton-playing skills of Grade 10 students, and the results clearly demonstrate that this purpose was successfully achieved. Both interventions produced significant improvements in footwork and court movement, stroke accuracy, and control, while comparative analysis showed that agility training yielded the strongest overall gains.

A notable contribution of this study is the empirical evidence on the relative effects of the two interventions. Despite reaction-time drills producing more synchronized multivariate improvements, agility training produced markedly higher absolute performance outcomes – an insight not yet emphasized in local or Southeast Asian school-based badminton research.

The findings support the study's initial assumption that agility and reaction-time training substantially improve badminton playing skills, affirming the relevance of both Dynamic Systems Theory and Information Processing Theory as the study's theoretical anchors. Agility gains reflect Dynamic Systems Theory's principle that movement adaptation emerges from repeated interaction with complex motor demands. Meanwhile, reaction-time gains confirm Information Processing Theory's view that faster sensory processing enhances motor responsiveness and decision accuracy.

In terms of educational implications, this study highlights the need for Physical Education programs to embed structured, evidence-based training modules that develop both movement mechanics and perceptual-response skills essential for racket sports. The findings suggest that agility-focused drills, in particular, deserve more prominence in PE curricula due to their strong impact on foundational skills. Future initiatives may include the development of standardized training guides, teacher-friendly modules, and school-level policy recommendations to integrate scientifically grounded skill-enhancement routines into regular PE schedules. More broadly, this study points toward a pathway for schools to elevate sports instruction by adopting low-cost, research-validated interventions that strengthen physical literacy, competitive readiness, and lifelong participation in physical activity.

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AI Declaration: This study utilized artificial intelligence tools to assist in preparing this article. Specifically, an AI assistant was used to help condense the full thesis manuscript into a reduced journal-article format and to enhance language quality, clarity, and tone, with human supervision and editing throughout. The author carefully reviewed and edited all outputs to ensure academic rigor and integrity.

Data Availability Statement: The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request. Requests for access will be evaluated in accordance with ethical guidelines and data privacy policies.