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Learning Outcomes Associated with the Execution of Short Service in Badminton Among Junior High School Students: The Proficiency of Eye-Hand Coordination in Motor Activities

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ABSTRACT

Purpose of the study: This research aimed to investigate the relationship between eye-hand coordination and the learning outcomes associated with badminton short service execution among junior high school students, and to determine the extent to which eye-hand coordination influences skill acquisition in this fundamental badminton technique.

Materials and methods: The study employed a quantitative non-experimental approach involving 27 male junior high school students aged 13-15 years from Medan City, Indonesia. Data collection utilized pre-test and post-test measurements of eye-hand coordination through a standardized ball throwing and catching test and short service proficiency using an adapted French Short Service Test. Students participated in an eight-week training program focused on developing eye-hand coordination and short service technique. Data were analyzed using SPSS version 26, employing descriptive statistics, Pearson correlation, and regression analysis.

Results: Findings revealed a significant positive correlation between eye-hand coordination scores and short service proficiency ($r = 0.783$, $p < 0.001$). Regression analysis indicated that eye-hand coordination accounted for approximately 61.3% of the variance in short service performance. Students with higher initial eye-hand coordination demonstrated greater learning improvements following the training intervention (19.1 ± 5.2 points) compared to students with lower coordination (13.7 ± 4.5 points).

Conclusions: Eye-hand coordination significantly influences badminton short service learning outcomes among junior high school students. The development of eye-hand coordination enhances students' ability to perform precise short services, suggesting that physical education curricula should incorporate specific coordination training to optimize badminton skill acquisition.

Keywords
badminton learning, short service, eye-hand coordination, motor skills, learning outcomes, junior high school students, physical education.

INTRODUCTION

Badminton represents one of the most widely practiced sports both recreationally and competitively across various educational settings globally. As a sport demanding precise motor control, rapid reflexes, and exceptional coordination, badminton presents unique learning challenges for students in physical education programs (Bailey, 2005; Xie, 2019). The short service, specifically, constitutes a fundamental technical skill in badminton that significantly influences match outcomes, particularly in doubles play where strategic placement can create immediate offensive advantages (Feng & Tao, 2023; Zhang et al., 2013).

The execution of a successful short service in badminton requires a complex integration of visual perception, cognitive processing, and fine motor control (Hammes & Link, 2024). This integrative process heavily relies on eye-hand coordination, which enables players to precisely control the shuttlecock's trajectory and landing position. Badminton is a demanding sport where players need to channel their attention to the game, emphasizing the necessity for athletes to concentrate on a particular object within the expansive playing area (Shen & Espeso, 2025). The ability to maintain focus, coordinate eye movements effectively, and exhibit agility are crucial components in achieving success in the sport of badminton (Chen et al., 2023).

Previous research (Shen & Espeso, 2025) has demonstrated that eye-hand coordination has a significant and substantial impact on badminton skills, with evidence showing its influence accounts for approximately 60-70% of an individual's overall badminton playing ability. This finding highlights the crucial role that eye-hand coordination plays in the development and mastery of essential badminton techniques and strategies. Additionally, studies have shown that coordination of hand-eye and specific exercise methods for service play have demonstrated significant influence on badminton performance (Jaworski & Żak, 2015).

These findings highlight the importance of coordination in badminton skill development, yet most studies have focused on advanced or collegiate athletes rather than younger students in developmental stages.

A critical gap in the existing literature concerns the specific influence of eye-hand coordination on learning outcomes associated with short service execution among junior high school students. Kasmad et al., (2020) investigated the improvement of backhand short service skills through peer teaching models, and another study examined the effectiveness of stroke technique learning methods (Ruslan et al., 2021), but neither study specifically isolated the influence of eye-hand coordination on learning outcomes in short service execution among junior high school students. This represents a significant oversight given the crucial role of coordination in badminton skill development, particularly during this critical period of motor skill acquisition. This oversight is significant, as junior high school constitutes a pivotal stage for motor skill development and sports specialization.

The rationale for this research stems from the need to better understand how physiological factors influence specific skill acquisition in badminton among adolescents. By identifying the relationship between eye-hand coordination and short service proficiency, physical education instructors can develop more targeted and effective teaching strategies to enhance learning outcomes. Furthermore, this research contributes to the broader understanding of motor learning processes in adolescents, with potential implications for curriculum development in physical education.

The primary objectives of this study are: (1) to assess the baseline eye-hand coordination abilities among junior high school badminton students, (2) to measure the relationship between eye-hand coordination and short service execution proficiency, (3) to determine the impact of focused eye-hand coordination training on short service learning outcomes, and (4) to develop practical recommendations for physical education instructors based on empirical findings.

MATERIALS AND METHODS

Study Participants

This study involved 27 male junior high school students from three public schools in Medan City, Indonesia. Participants were aged between 13 and 15 years (mean age = 14.2 ± 0.8 years) and were selected through purposive sampling based on the following inclusion criteria: (1) enrolled in regular physical education classes, (2) no prior formal badminton training outside of standard physical education curriculum, (3) free from any physical disabilities or injuries that might affect performance, and (4) willing to participate in the entire duration of the study with parental consent. The sample size determination was based on a power analysis with α = 0.05, power = 0.80, and anticipated medium effect size (f² = 0.15), indicating a minimum required sample of 25 participants.

Study Organization

This study used a quantitative design with a non-experimental approach, aiming to measure the relationship between eye-hand coordination and short service proficiency in badminton. The research was conducted over 12 weeks, with the first week dedicated to pre-testing, eight weeks devoted to badminton instruction and training interventions, and the final week allocated for post-testing. Training sessions were conducted twice weekly, each lasting 90 minutes, under the supervision of qualified physical education instructors and the research team.

The research procedures complied with ethical guidelines for research involving human subjects and received approval from the institutional ethics committee (approval number: ETH-2024-087). Written informed consent was obtained from both participants and their parents or legal guardians prior to the commencement of the study.

Test and Measurement Procedures

Table 1. *Test and Measurement Procedures for Eye-Hand Coordination and Short Service Proficiency*

Test/Procedure	Description	Methodology/Source
Eye-Hand Coordination Assessment	Ball Throwing and Catching Test: Participants throw a tennis ball against a wall from a 2-meter distance and catch it upon return, aiming for maximum successful catches in 30 seconds. Three trials were conducted for each participant, with the highest score recorded. Grid Concentration Exercise: Participants identify number sequences within a grid of random numbers under timed conditions.	Halim et al. (2023)[1]
Short Service Proficiency Assessment	Participants perform 20 short services aimed at specific target areas on the opposite court. Points are awarded based on the accuracy of the shuttlecock's landing position, with the most accurate zone receiving 5 points and the outermost zone 1 point. The total score out of 100 reflects the participant's proficiency.	French Short Service Test (adapted) by Rasmussen & Zee (2021)
Training Intervention	Participants engage in a structured badminton training program with emphasis on short service technique and eye-hand coordination. Exercises include: 1. Alternating hand wall tapping exercises 2. Shuttle balancing on the racket 3. Target practice with progressive difficulty 4. Reaction drills with visual cues 5. Depth perception exercises	Structured badminton training with regular feedback

Statistical Analysis

Quantitative data were analyzed using SPSS version 26.0. Descriptive statistics including means, standard deviations, and ranges were calculated for all measured variables. The normality of data distribution was confirmed using the Shapiro-Wilk test. Pearson's correlation coefficient was used to examine the relationship between eye-hand coordination scores and short service proficiency. A simple linear regression analysis was conducted to determine the predictive value of eye-hand coordination for short service performance. Paired t-tests were employed to assess the significance of changes between pre-test and post-test measures. For all statistical analyses, the level of significance was set at $p < 0.05$.

RESULTS

The participants' characteristics and baseline performance measures are presented in Table 1. The 27 male students had a mean age of 14.2 ± 0.8 years, with varying levels of prior recreational exposure to badminton but no formal training. The baseline

assessments revealed considerable variation in both eye-hand coordination abilities and short service proficiency among the participants.

Table 2. Participant Characteristics and Baseline Performance Measures (N=27)

Characteristic	Mean ± SD	Range
Age (years)	14.2 ± 0.8	13-15
Height (cm)	157.5 ± 7.3	145-170
Weight (kg)	49.6 ± 6.5	40-63
Years of PE participation	8.3 ± 0.9	7-10
Eye-hand coordination score (pre-test)	14.7 ± 4.2	7-22
Short service score (pre-test)	42.3 ± 8.7	28-60

Relationship Between Eye-Hand Coordination and Short Service Proficiency

Pearson correlation analysis revealed a strong positive correlation between eye-hand coordination scores and short service proficiency in both pre-test ($r = 0.783$, $p < 0.001$) and post-test ($r = 0.815$, $p < 0.001$) measurements. This strong correlation indicates that students with better eye-hand coordination demonstrated greater proficiency in executing the badminton short service. The regression analysis further supported these findings, with eye-hand coordination explaining approximately 61.3% of the variance in short service performance ($R^2 = 0.613$, $F(1,25) = 39.56$, $p < 0.001$). The regression equation can be expressed as: Short Service Score = 20.52 + 1.48(Eye-Hand Coordination Score).

Training Intervention Effects

Following the 8-week training intervention, significant improvements were observed in both eye-hand coordination and short service proficiency. The paired t-test results indicated statistically significant improvements in both measures, as detailed in Table 3.

Table 3. *Pre-Test and Post-Test Comparisons of Key Performance Measures (N=27)*

Measure	Pre-Test (Mean ± SD)	Post-Test (Mean ± SD)	Mean Difference	t-value	p-value	Effect Size (Cohen's d)
Eye-hand coordination score	14.7 ± 4.2	19.3 ± 3.8	4.6	11.27	<0.001	1.15
Short service score	42.3 ± 8.7	58.6 ± 10.2	16.3	14.92	<0.001	1.72

The large effect sizes (Cohen's d > 0.8) for both measures indicate not only statistically significant but also practically meaningful improvements following the training intervention.

Differential Learning Outcomes Based on Initial Eye-Hand Coordination

To examine whether initial eye-hand coordination levels influenced learning outcomes, participants were divided into two groups based on their pre-test eye-hand coordination scores: lower coordination group (scores < 15, n = 14) and higher coordination group (scores ≥ 15, n = 13). The comparative analysis of these groups' learning outcomes is presented in Table 4.

Table 4. Comparison of Learning Outcomes Between Groups with Different Initial Eye-Hand Coordination Levels

Measure	Lower Coordination Group (n=14)	Higher Coordination Group (n=13)	t-value	p-value
Short service improvement (points)	13.7 ± 4.5	19.1 ± 5.2	2.87	0.008
Learning rate (points/week)	1.71 ± 0.56	2.39 ± 0.65	2.93	0.007
Technique mastery score*	3.21 ± 0.58	4.15 ± 0.55	4.41	<0.001

*Technique mastery was assessed on a 5-point scale by trained instructors at the conclusion of the training period.

These results indicate that while both groups showed significant improvement, students with higher initial eye-hand coordination demonstrated greater learning outcomes in terms of short service improvement, learning rate, and technique mastery.

DISCUSSION

Interpreting the Outcomes of Research Endeavors

The present study investigated the relationship between eye-hand coordination and learning outcomes associated with badminton short service execution among junior high school students. The findings revealed a strong positive correlation between eye-hand coordination and short service proficiency, suggesting that eye-hand coordination is a critical factor in the acquisition and performance of this fundamental badminton skill.

The strong correlation ($r = 0.783$) between eye-hand coordination and short service proficiency aligns with the findings of (Kasmad et al., 2020), who reported that hand-eye coordination significantly influenced badminton skills. However, our study extends these findings specifically to junior high school students and quantifies the contribution of eye-hand coordination to short service performance at approximately 61.3%, which is considerably higher than the 28.36% reported by Wong et al., (2019). This difference may be attributed to the age group studied, as younger players at earlier stages of motor development may rely more heavily on fundamental coordinative abilities than experienced players who have developed compensatory strategies and more refined technique.

The significant improvements observed in both eye-hand coordination and short service proficiency following the training intervention demonstrate that these abilities are trainable and responsive to targeted instruction in junior high school students. This finding supports the work of (Maramis et al., 2021), who found that structured learning interventions could significantly improve backhand short serve skills in students. However, while Jaworski & Żak, (2015) focused on peer teaching methods, our study

highlights the importance of specifically targeting underlying coordinative abilities as part of technical skill development.

Evaluating in Relation to Antecedent Studies

The findings of the present study both support and extend previous research in this field. Existing studies have demonstrated that eye-hand coordination and wrist flexibility have a significant relationship with short service ability in badminton(Jaworski et al., 2020; Wong et al., 2019). Similarly, the coordination of hand-eye movements and specific exercise methods for service execution have been shown to exert a substantial influence. The current research quantifies the predictive value of eye-hand coordination for service performance and illustrates its impact on learning outcomes over a targeted training period. Additionally, the study reveals differential learning outcomes based on initial eye-hand coordination levels.

The discovery of these differential learning outcomes based on initial eye-hand coordination levels is particularly noteworthy. The results indicate that students with higher initial eye-hand coordination exhibited greater improvements in short service performance, a faster learning rate, and higher technique mastery scores. This suggests that while all students benefit from training, those with a higher baseline level of eye-hand coordination are better equipped to translate instruction into skill gains (Carlson et al., 2013). These findings align with previous research demonstrating that coordination training can enhance power and agility in young soccer players (González-Férnandez et al., 2021). Furthermore, studies have shown that stroboscopic training can lead to improvements in visuomotor abilities (Hülsdünker et al., 2020).

The results of this investigation hold several implications for badminton instruction and training. First, eye-hand coordination should be recognized as a critical component of badminton short service proficiency. Accordingly, assessment and training protocols should prioritize the development of eye-hand coordination alongside technical instruction.(Huang et al., 2025) Secondly, the finding that initial eye-hand coordination levels predict learning outcomes suggests that individualized instruction may be beneficial. Students with lower initial eye-hand coordination may require more targeted interventions to improve their coordinative abilities before or during technical training.

Finally, the success of the training intervention suggests that structured, targeted training programs can effectively enhance both eye-hand coordination and badminton short service proficiency in junior high school students. However, further studies are required to explore these topics in greater depth (Purnomo & Yendrizal, 2020; Toshniwal et al., 2022).

CONCLUSION

This study provides compelling evidence for the significant role of eye-hand coordination in badminton short service execution among junior high school students. The findings underscore the importance of eye-hand coordination as a predictor of short service proficiency and highlight its influence on learning outcomes during a targeted training intervention. The study's results emphasize the potential benefits of integrating eye-hand coordination training into badminton instruction for junior high school students, and suggest that early assessment and individualized interventions may optimize skill development. The results emphasize the need for future research to address existing gaps in our understanding and to refine the approaches to optimizing badminton skill acquisition in young athletes.

While this study provides valuable insights into the relationship between eye-hand coordination and badminton short service proficiency, several avenues for future research remain. Longitudinal studies could investigate the long-term effects of eye-hand coordination training on badminton skill development. Investigating how to train the balance of badminton players is also important. Further research could also explore the influence of other factors, such as wrist flexibility, reaction time, and spatial awareness, on badminton short service proficiency. Comparative studies could examine the effectiveness of different eye-hand coordination training methods, such as sport-specific drills versus general motor skills training.

In interpreting the findings of this study, it is important to consider several methodological limitations. The sample size was relatively small, and the participants were drawn from a single school district, which may limit the generalizability of the results. Future studies should employ larger, more diverse samples to increase the external validity of the findings. The study design was quasi-experimental, lacking random assignment to treatment groups, which may introduce selection bias and confounding variables. Additionally, the assessment of eye-hand coordination was based on a single test, which may not fully capture the complexity of this construct.

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CONFLICT OF INTEREST

The author declares no conflicts of interest.

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