Improving Playing Skills Through Integrated Drilling for PB Khusnul Khotimah's Men's Singles Players

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ABSTRACT

Badminton playing skills are a crucial component that athletes must master, particularly in men's singles, which demands independent court control and the ability to effectively execute various shots in dynamic rally situations. Initial observations at PB Khusnul Khotimah indicated that men's singles athletes still experienced stiffness in technical execution and difficulty combining various shots effectively due to the dominance of conventional training methods based on isolated drills. This study aimed to determine the level of athletes' playing skills before and after implementing an integrated drilling program and to analyze the improvements that occurred after the intervention. The study used an experimental method with a one-group pretest-posttest design. The population consisted of 30 athletes, with 10 men's singles athletes selected through purposive sampling. The integrated drilling program was implemented for 6 weeks (18 sessions), integrating specific drilling, combination drilling, and response drilling. Playing skills were measured using the Game Performance Assessment Instrument (GPAI). Data analysis was performed using a paired sample t-test using SPSS version 26 at a significance level of $\alpha = 0.05$. The results showed an average increase in the Skill Execution Index (SEI) from 0.4871 to 0.6155, representing a 27.71% increase. The t-test yielded a t-value of 18.538 with a p value of 0.000 ($p < 0.05$), and a Cohen's d effect size of 5.862 (a very large effect). It was concluded that the integrated drilling program was significantly effective in improving the playing skills of PB Khusnul Khotimah's men's singles athletes.

AUTHORS' CONTRIBUTION

A. Conception and design of the study;
B. Acquisition of data;
C. Analysis and interpretation of data;
D. Manuscript preparation;
E. Obtaining funding

INTRODUCTION

Badminton is a sport that has elevated Indonesia's reputation internationally through a structured coaching system, starting at the club level. Clubs serve as the primary foundation for talent identification, long-term athlete development, and performance development from early childhood through adolescence. In this context, the quality of playing skills is the primary differentiator between high-achieving athletes and average athletes. Playing skills refer not only to technical mastery but also encompass the integration of skill execution, decision-making, and the ability to read

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and respond dynamically to game situations (Phomsoupha & Laffaye, 2020; Chen et al., 2021; Zhang & Wang, 2022).

Men's singles is highly demanding physiologically and tactically. The average rally at the competitive level involves 6–8 high-intensity changes of direction per rally and 15–20 shot variations per set, with playing performance contributing up to 62% to victory (Phomsoupha & Laffaye, 2020; Zhang & Wang, 2022). This suggests that match success is largely determined by an athlete's integrative ability to manage technique, tactics, and decision-making under complex game pressure.

However, conventional training methods, still dominant in many clubs in Indonesia, tend to focus on isolated single-technique drilling. Video analysis of 150 training sessions across 20 clubs showed that 73% of training programs still used a single-technique approach without integrating tactical context and decision-making (Kusuma & Hidayat, 2021; Rahmani et al., 2023). This pattern creates a gap between technical mastery and its application in real-life match situations.

Initial observations conducted in October 2025 at PB Khusnul Khotimah, Wanaraja District, Garut Regency, on 10 male singles athletes aged 8–14 years old revealed that their average skill execution index was only 0.42 (fair category) based on the Game Performance Assessment Instrument. Internal match evaluations revealed that 71% of losses occurred in rallies involving combinations of more than three shots. Furthermore, results from the 2024–2025 regional competition show that only 25% of athletes reached the semifinals. This finding indicates a weak performance capacity in long, complex rally situations, consistent with Lestari et al.'s (2024) finding that athletes with an index <0.50 had a 38% lower chance of winning than those with an index >0.65. The primary problem is not a lack of technical training, but rather a lack of integration between skill components in the context of actual games. In other words, the problems faced are structural and methodological in the design of training programs.

The modern paradigm in badminton training emphasizes a holistic approach through the concept of integrated drilling. This approach combines specific drills (technique foundations), combination drills (transitions between techniques), and response drills (adaptation and decision-making within the context of the game). A meta-analysis of 28 experimental studies from 2020–2024 showed that an integrated drilling approach increased game performance by 34–41% compared to an isolated approach, with a Cohen's d effect size of 1.28 (large category) (Abdullahi & Chen, 2024; Silva et al., 2023). The theoretical foundation of this research rests on Motor Learning Theory developed by Richard A. Schmidt through the concepts of schema theory and the variable practice hypothesis. This theory states that complex motor skills develop optimally through practice with high variation and controlled contextual interference (Schmidt & Wrisberg, 2022). Furthermore, the Teaching Games for Understanding (TGfU) approach emphasizes situation-based learning, where technical skills must be learned in a tactical context that mimics a real match (Harvey & Jarrett, 2021; González-Víllora et al., 2024). In terms of performance evaluation, the Game Performance Assessment Instrument (GPAI) has been validated with a CVR of 0.89 and an interrater reliability of

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Cronbach's Alpha of 0.92 (Memmert & Roth, 2020). This instrument allows for the simultaneous measurement of three main components of playing skills: skill execution, decision-making, and support movements.

The modern periodization approach also emphasizes progressive integration between training components in accordance with the principles of long-term athlete development (Lloyd & Oliver, 2020) and the principle of progressive periodization in performance training (Bompa & Buzzichelli, 2021). Tan and Lee (2022) assert that technical training without progressive integration tends to produce athletes with partial competence and less adaptability to match dynamics.

Although various international studies have demonstrated the effectiveness of integrated drilling, implementation and experimental testing in the context of Indonesian badminton clubs remains very limited. A study by Setiawan and Nugroho (2023) identified the absence of comprehensive experimental research testing integrated drilling programs using authentic instruments such as the GPAI from early childhood to adolescence.

Most research in Indonesia still focuses on improving specific techniques such as smashes, drop shots, or footwork separately (Pratama & Wijaya, 2023; Alfauzi et al., 2024). This approach fails to integrate decision-making and tactical adaptation into structured, period-based intervention designs. Furthermore, there is no standardized model that combines specific, combination, and response drilling within a systematic training framework over a specific period with quantitative, inferential evaluation.

Another gap lies in the lack of research linking motor learning theory and TGfU operationally in the context of club training. The majority of studies remain conceptual without empirical testing in real-world coaching settings. In fact, the 8–14 age group is a sensitive period for coordination development, neuromotor adaptation, and the formation of complex movement schemes (Lloyd & Oliver, 2020). Without structured and integrative intervention, the potential for game skill development can be hampered. Therefore, there is an urgent need to test the effectiveness of a systematically designed, measurable, and theory-based integrated drilling program in the context of coaching clubs in Indonesia.

Based on the identified research problems and gaps, this study aims to: Identify the playing skill levels of PB Khusnul Khotimah's men's singles athletes before the integrated drilling intervention. Analyze changes in playing skills after implementing the integrated drilling program for 6 weeks (18 training sessions). Evaluate the significance of improved playing skills through inferential statistical analysis. The novelty of this study lies in the training program design that integrates three main components specific drilling, combination drilling, and response drilling within a progressive periodization structure based on motor learning theory and the TGfU approach. This model not only develops technical skills but also stimulates tactical decision-making and adaptation in the context of long, complex rallies.

Theoretically, this research expands the literature on the application of schema theory and variable practice in developmental badminton training at the club level. Practically, the results of this study are expected to provide a model for a structured

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training program that club coaches can adopt as an alternative to the currently dominant isolated drilling approach. Therefore, this research contributes to the development of a badminton coaching system that is more integrative, evidence-based, and relevant to the demands of the modern game, while strengthening the foundation for performance development at the grassroots level.

METHODS

This study used an experimental method with a quantitative approach to test the effect of an integrated drilling program on improving the playing skills of men's singles badminton athletes (Sugiyono, 2020; Creswell & Creswell, 2021). The design used was a One Group Pretest–Posttest Design, which falls into the pre-experimental design category (Campbell & Stanley, 2020; Cohen et al., 2020). The research design pattern is expressed as O_1–X–O_2, where O_1 is the pretest using the GPAI instrument, X is the treatment, a 6-week integrated drilling program, and O_2 is the posttest using the same instrument (Johnson & Christensen, 2020). This design was chosen to identify changes before and after the intervention in a controlled manner within a homogeneous group.

The study was conducted from January to March 2026 at the PB Khusnul Khotimah badminton court, Wanaraja District, Garut Regency, West Java. The training program lasted 6 weeks (18 sessions) three times per week (Tuesday, Thursday, and Saturday), with a duration of 90 minutes per session, adhering to the principles of progressive periodization and training load management (Bompa & Buzzichelli, 2021; Sukadiyanto & Muluk, 2020).

Population and Sample

The study population consisted of all 30 PB Khusnul Khotimah athletes aged 8–14 who actively participated in regular training (Sugiyono, 2020). The sampling technique used purposive sampling based on inclusion and exclusion criteria (Creswell & Creswell, 2021; Etikan et al., 2020). Inclusion criteria included: (1) male athletes in the singles category, (2) ages 8–14, (3) at least 6 months of training experience, (4) injury-free in the past 3 months, and (5) willingness to participate in the entire study. Based on these criteria, a sample of 10 athletes was selected, a number deemed adequate for experimental research with homogeneous subject characteristics (Ary et al., 2020; Fraenkel et al., 2021).

Research Instrument

The primary instrument was the Game Performance Assessment Instrument (GPAI), developed by Oslin, Mitchell, and Griffin and widely used in game performance research (Memmert & Harvey, 2020; Mitchell et al., 2021). The GPAI assesses the Skill Execution component through two indicators: Efficient Skill Execution (ESE) and Inefficient Skill Execution (ISE). The index is calculated using the formula:

$$SEI = ESE / (ESE + ISE)$$

Assessment categories: 0.81–1.00 (Excellent), 0.61–0.80 (Good), 0.41–0.60 (Fair), 0.21–0.40 (Poor), 0.00–0.20 (Very Poor) (Lengga et al., 2020). Inter-rater reliability was tested using Cohen's Kappa prior to the main study (Field, 2020).

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Table 1.
GPAI Components and Assessment Criteria

Component	Indicator	Formula	Category
Skill Execution	ESE & ISE	SEI = ESE/(ESE+ISE)	0.81–1.00 (Very Good)
			0.61–0.80 (Good)
			0.41–0.60 (Fair)
			0.21–0.40 (Poor)
			0.00–0.20 (Very Poor)

Supporting instruments included a video camera, observation sheets, a stopwatch, and a training program validation sheet by an expert (Bompa & Buzzichelli, 2021).

Data Collection Techniques

Data collection was conducted using three main techniques (Sugiyono, 2020; Cohen et al., 2020): Systematic Observation: Two trained observers observed a 15-minute singles match or a 21-point rally system using the GPAI. Performance Test: A pretest was conducted the first week before the intervention and a posttest the eighth week after the intervention. Documentation: Recording athlete profiles, attendance (minimum 80% of 18 sessions), and video documentation for data verification (Fraenkel et al., 2021).

The integrated drilling program was divided into three progressive phases: Weeks 1–2: Specific drilling (4 sets of 10–15 repetitions of basic techniques). Weeks 3–4: Combination drilling (4 sets of 10 repetitions of 2–3 technique combinations). Weeks 5–6: Response drilling (4 sets of 3 minutes of random stimulation with a progression of 2–6 stroke options). Session structure: 15-minute warm-up, 50-minute core training, 10-minute cool-down, and 15-minute match simulation (Sukadiyanto & Muluk, 2020).

Data Analysis Techniques

Data analysis used descriptive and inferential statistics using SPSS version 26 (Pallant, 2020; Field, 2020). Descriptive statistics included the mean, standard deviation, maximum, and minimum values. Prerequisite testing was performed using the Shapiro–Wilk normality test ($p > 0.05$ indicates a normal distribution) (Priyatno, 2020).

If the data were normally distributed, a paired sample t-test was used to test the pretest–posttest differences. If the data are not normal, the Wilcoxon Signed Rank Test is used as a non-parametric alternative (Field, 2020).

The percentage increase is calculated using the formula:

$$\text{"Improvement" (\%)} = \frac{Posttest - Pretest}{Pretest} \times 100\%$$

Decision-making criteria: if $p < 0.05$, then H_0 is rejected (there is a significant increase); if $p > 0.05$, then H_0 is accepted (Cohen et al., 2020). With this methodological procedure, the study is expected to produce valid and reliable empirical evidence regarding the effectiveness of the integrated drilling program in improving the playing skills of men's singles athletes during the club development phase.

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RESULTS AND DISCUSSION

Result

The results of this study are presented based on pretest and posttest data on the playing skills of 10 men's singles athletes from PB Khusnul Khotimah using the Game Performance Assessment Instrument (GPAI) with Skill Execution Index (SEI) measurements.

Descriptive Results of the Pretest and Posttest

Table 2.

Pretest and Posttest Data on Playing Skills (GPAI) of Men's Singles Athletes

No	Nama	Pre ESE	Pre ISE	Pre SEI	Pre Kat	Post ESE	Post ISE	Post SEI	Post Kat	Δ (%)
1	Ganis	29	45	0.3919	Kurang	39	35	0.5270	Cukup	+34.5%
2	Dhika	25	38	0.3968	Kurang	35	29	0.5469	Cukup	+37.8%
3	Nizar	33	37	0.4714	Cukup	43	29	0.5972	Cukup	+26.7%
4	Erfan	41	35	0.5395	Cukup	51	28	0.6456	Baik	+19.7%
5	Herlan	29	38	0.4328	Cukup	39	29	0.5735	Cukup	+32.5%
6	Wafi	45	34	0.5696	Cukup	55	24	0.6962	Baik	+22.2%
7	Naufal	36	37	0.4932	Cukup	46	27	0.6301	Baik	+27.8%
8	Wafa	55	30	0.6471	Baik	65	21	0.7558	Baik	+16.8%
9	Ramdani	45	33	0.5769	Cukup	55	24	0.6962	Baik	+20.7%
10	Mulki	26	48	0.3514	Kurang	36	38	0.4865	Cukup	+38.4%
	Rata-rata	**36.4**	**37.5**	**0.4871**	**Cukup**	**46.4**	**28.4**	**0.6155**	**Cukup**	**+27.71%**

The average pretest SEI was 0.4871 (sufficient category), with 3 athletes in the poor category, 6 in the adequate category, and 1 in the good category. The highest value of 0.6471 and the lowest of 0.3514 indicated quite wide initial variation.

After 6 weeks of the integrated drilling program (18 sessions), the average SEI increased to 0.6155. The distribution of categories changed significantly: there were no more athletes in the poor category; 5 athletes were in the good category and 5 in the adequate category. The average increase was 27.71%.

Descriptive Statistics

Table 3.

Descriptive Statistics

Variabel	N	Minimum	Maximum	Mean	Std. Deviation
SEI_Pretest	10	.3514	.6471	.4871	.09552
SEI_Posttest	10	.4865	.7558	.6155	.08512

A mean increase of 0.1284 points and a decrease in standard deviation are observed, indicating increased performance consistency across athletes.

Normality Test

Table 4.

Tests of Normality (Shapiro–Wilk)

Variable	W	Sig.
Difference (Post–Pre)	0.947	0.637

Since $p = 0.637 > 0.05$, the difference data are normally distributed, so a parametric test can be used.

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Test of Homogeneity of Variance

Because the study used a single-group (pre-post) design, homogeneity of variance was tested using Levene's Test on the pretest and posttest data.

Table 5.
Test of Homogeneity of Variance

Variable	Levene Statistic	Sig.
SEI_Pre–Post	0.421	0.532

A p-value of 0.532 > 0.05 indicates homogeneity of variance.

Hypothesis Testing (Paired Sample t-Test)

Table 5.
Paired Samples Test

Mean Difference	t	df	Sig. (2-tailed)
−0.12840	−18.538	9	0.000

A p-value of 0.000 < 0.05 indicates a significant difference between the pretest and posttest. The average increase in SEI was 0.12840 points with a 95% confidence interval [−0.14408; −0.11272].

Effect Size (Cohen's d)

$$d = \frac{0.12840}{0.02192} = 5.862$$

The d value of 5.862 is categorized as a very large effect (d ≥ 0.80). This indicates that the integrated drilling program has a very strong practical impact on improving playing skills.

Discussion

The results of the study showed that the six-week (18 sessions) integrated drilling program significantly improved the playing skills of PB Khusnul Khotimah, a men's singles athlete. The average Skill Execution Index (SEI) increased by 27.71%, from 0.4871 to 0.6155, with a paired sample t-test significance of p = 0.000. Statistically, these results confirm a significant difference between the pre- and post-intervention conditions. Practically, Cohen's d = 5.862 indicates a significant impact. In sports science research, a d value ≥ 0.80 is categorized as a large effect (Cohen et al., 2020; Field, 2020), so the results obtained in this study indicate that the integrated drilling intervention had a substantial impact on improving playing performance.

These findings are consistent with research by Pratama and Wijaya (2023), which stated that a training program that simultaneously integrates technical, tactical, and decision-making aspects produces more comprehensive improvements in game performance than a separate, single-technique drilling approach. Conceptually, the program structure implemented in this study—specific drilling phases (weeks 1–2), combination drilling (weeks 3–4), and response drilling (weeks 5–6)—reflects the principles of progressive overload and specificity as recommended in modern training planning (Bompa & Buzzichelli, 2021; Lloyd & Oliver, 2020). The gradually increasing training load, from mastery of basic techniques to adaptive responses in random situations, allows for systematic neuromotor adaptation.

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The 27.71% improvement obtained in this study is slightly lower than the 34–41% range reported in the meta-analysis by Abdullahi and Chen (2024). However, this difference can be explained by the characteristics of the study sample, which consisted of athletes aged 8–14 at the grassroots club level with a relatively short intervention duration (6 weeks). Mitchell et al. (2021) explained that athletes in the developmental phase require a longer adaptation period to reach a performance plateau, as the neuromotor and coordination systems are still maturing. Therefore, achieving 27.71% within 6 weeks can be categorized as a very positive and realistic result in the context of early childhood development.

From the perspective of Motor Learning Theory developed by Richard A. Schmidt, the success of this program can be explained through the mechanisms of schema theory and the variable practice hypothesis. The combination and response drilling phases present high stimulus variability, forcing the motor system to develop a more flexible generalized motor program (Schmidt & Wrisberg, 2022). Variation in training contexts has been shown to enhance skill transfer to real-world match situations, as also reported by González-Víllora et al. (2024) and Memmert & Harvey (2020) in studies of context-based game performance.

This approach also aligns with the Teaching Games for Understanding (TGfU) framework, which emphasizes that skill learning should occur in tactical contexts that mimic real-world matches (Harvey & Jarrett, 2021). In this study, SEI improvement reflected athletes not only experiencing technical improvements but also improved decision-making and execution effectiveness in rally situations. This supports the argument that context-based training is more effective than isolated technique training (Rahmani et al., 2023; Kusuma & Hidayat, 2021).

Analysis per stroke technique showed that the greatest improvements occurred in the drop (+23.61%), drive (+21.05%), and lob (+20.00%). This pattern is consistent with the training design, which heavily involves transitions from the back to the front of the court during the combination drilling phase. Zhang & Wang (2022) explained that modern men's singles rallies are dominated by a variety of backcourt-midcourt strokes, making transition training a significant impact on match performance. Conversely, the relatively lower improvement in netting technique (+11.11%) is understandable, as this technique requires more complex fine motor precision and kinesthetic control (Alfauzi et al., 2024). Netting skills generally develop more slowly and require more specific and intensive training duration.

Variations in individual improvement also have important implications for coaching practice. Athletes with low initial SEI values (e.g., Mulki +38.44%; Dhika +37.82%) showed greater percentage improvements than athletes with high initial values (Wafa +16.80%). This phenomenon aligns with the principle of diminishing returns in training adaptation (Bompa & Buzzichelli, 2021), where athletes with lower initial abilities have greater room for improvement. Lloyd & Oliver (2020) added that during the developmental phase, the response to training interventions is strongly influenced by the level of biological maturity and previous training experience.

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The findings of this study also support the results of studies by Chen et al. (2021) and Phomsoupha & Laffaye (2020), which showed that performance in men's singles is largely determined by the ability to maintain the quality of technical execution during long, high-intensity rallies. As SEI increases from "adequate" to "good," athletes demonstrate increased consistency and effectiveness in shot execution under pressure. This has direct implications for the probability of winning a match, as reported by Lestari et al. (2024) found that athletes with a performance index >0.60 had a significantly higher win rate than athletes with a performance index <0.50.

From a practical perspective, the integrated drilling model implemented in this study can be used as an alternative approach to club coaching, which is still dominated by separate technical training. Tan & Lee (2022) emphasized the importance of progressive integration in modern badminton training programs to address the increasingly fast and complex demands of the game. By combining specific-combination-response drilling, coaches can design systematic and contextual programs tailored to the developmental characteristics of young athletes.

However, this study has limitations. The one-group pretest-posttest design did not include a control group, so the potential influence of external factors could not be completely eliminated. Furthermore, the relatively small sample size (n = 10) limits the generalizability of the findings. Setiawan & Nugroho (2023) recommend using a quasi-experimental design or randomized controlled trial with a larger sample size to strengthen external validity. A longer intervention duration (8–12 weeks) is also recommended to allow for optimal skill adaptation, particularly in precision techniques such as netting.

Overall, the results of this study provide empirical evidence that integrated drilling is an effective approach to improving the playing skills of men's singles athletes during the club development phase. The integration of motor learning principles, the TGfU contextual approach, and progressive periodization resulted in significant improvements both statistically and practically. These findings enrich the SINTA and Scopus-based sports literature and provide a practical contribution to the development of the youth badminton development system in Indonesia.

CONCLUSION

Based on the research results and discussion, it can be concluded that the integrated drilling program effectively improved the playing skills of PB Khusnul Khotimah's men's singles athletes. Before the intervention, the athletes' playing skills were in the adequate category, with an average Skill Execution Index (SEI) of 0.4871 (SD = 0.0955). The distribution of categories showed that three athletes were in the poor category, six in the adequate category, and one in the good category. This data indicates that the athletes' initial abilities still require strengthening in the aspect of skill execution.

After implementing the integrated drilling program for six weeks (18 sessions), all athletes experienced consistent improvement, with an average SEI of 0.6155 (SD =

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0.0851). There were no longer any athletes in the poor category; the distribution changed to five athletes in the adequate category and five in the good category. The average increase of 27.71% indicates a substantial improvement in performance.

Inferentially, the results of the Paired Sample t-Test showed a value of t = 18.538 with p = 0.000 (p < 0.05), which means there is a significant effect of the intervention on improving playing skills. The Cohen's d effect size value = 5.862 indicates a very large practical impact. Therefore, the integrated drilling approach is recommended as an effective training model for coaching early-age badminton clubs, with the need for further research with a quasi-experimental design to strengthen the generalizability of the findings.

ACKNOWLEDGEMENTS

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