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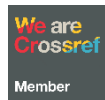
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The effect of drill and play methods on karate students' Gyaku Tsuki Kumite skills

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ABSTRACT

This study aimed to examine the effect of Drill and Game-Based Practice on Kumite Gyaku Tsuki technique skills among extracurricular Karate students at SMK Negeri 1 Bintan Utara. A total of 31 male students from grade 10 participated and were divided into an experimental group (n = 16) receiving Drill and Game-Based Practice, and a control group (n = 15) following conventional Karate training. The study employed a quasi-experimental design with pretest and posttest assessments. Skill performance was measured through standardized Kumite Gyaku Tsuki tests evaluated by certified national Karate referees. Data were analyzed using descriptive statistics, paired t-tests, and independent sample t-tests. Results indicated significant improvements in both groups, with the experimental group showing a greater increase in posttest scores (Mean = 42.13) compared to the control group (Mean = 33.47). Statistical analysis confirmed a significant difference between groups ($p < 0.05$). In conclusion, Drill and Game-Based Practice effectively enhances Kumite Gyaku Tsuki skills, and incorporating game-based exercises offers superior results compared to conventional training methods.



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Introduction

Karate is a traditional martial art that integrates physical, technical, and cognitive components, particularly in the context of Kumite (sparring), where speed, accuracy, timing, power, and postural control are simultaneously required (Vasconcelos et al., 2024; Yang et al., 2024). One of the most fundamental and frequently executed techniques in Kumite is the Gyaku Tsuki, a reverse punch performed with opposite hand-to-foot alignment. Biomechanically, this technique requires coordinated hip rotation, lower-limb stabilization, trunk acceleration, and precise upper-limb extension to generate optimal force and accuracy. In competitive settings, Gyaku Tsuki is often used as a decisive counterattack technique due to its linear speed and scoring potential. Therefore, mastery of this specific technique is not only essential for competition performance but also represents an important indicator of motor coordination, timing, and technical proficiency in Karate practitioners.

Traditional Karate training methods typically rely on structured and repetitive drill-based exercises, emphasizing technical repetition to build muscle memory and movement precision (Bouyer et al.,

2024; Cavoretto et al., 2024; H. Li et al., 2024). Drill Practice in this context refers to systematic, instructor-led repetition of isolated techniques under controlled conditions, focusing on correct form, stance, and execution consistency. While such methods are widely accepted in martial arts pedagogy, contemporary motor learning theories suggest that variability of practice, contextual interference, and task engagement may enhance skill acquisition and adaptability. Research in sport science indicates that integrating contextualized and play-oriented activities into training can improve intrinsic motivation, decision-making, and adaptive motor responses (Das et al., 2024; di Fronso et al., 2024; Pinto-Escalona et al., 2024).

Game-Based Practice represents an alternative pedagogical approach in which technical skills are embedded within structured, interactive activities that simulate competitive or semi-competitive scenarios (Dráždilová et al., 2024; Huang et al., 2024; Soltani et al., 2024). Unlike conventional drills that isolate movements, game-based formats introduce dynamic elements such as timing pressure, opponent interaction, scoring objectives, and situational constraints. Studies conducted in sports such as soccer, basketball, and gymnastics have reported improvements in skill retention, tactical awareness, and psychological engagement when game elements are incorporated into training sessions. However, the transferability of these findings to Karate, particularly to isolated striking techniques like Gyaku Tsuki, remains insufficiently explored.

Although several studies have compared traditional drills with modified or contextualized training in martial arts (Arovah & Putri, 2024; Dong et al., 2024; Vonthron et al., 2024; Yazdanjue et al., 2024), most investigations focus on general physical fitness, coordination, or overall performance rather than technique-specific outcomes. Moreover, relatively few studies have assessed technical performance using standardized scoring systems evaluated by certified referees. As a result, there is limited empirical evidence regarding whether game-based approaches provide measurable advantages in improving a specific Karate technique when assessed through formal performance criteria.

This research gap is particularly relevant in the context of school-based extracurricular Karate programs. Unlike professional clubs or competitive training centers, school extracurricular settings often operate under time constraints, limited resources, and heterogeneous student backgrounds. Participants may vary in prior experience, belt level, and motor proficiency, which increases the importance of selecting efficient and engaging training strategies. Optimizing instructional methods in such environments is critical to ensure both technical development and sustained student participation (Chang et al., 2024; Lu et al., 2024).

Furthermore, from a motor learning perspective, it remains unclear whether embedding Gyaku Tsuki practice within game-based scenarios enhances skill execution quality beyond what is achieved through repetitive drills alone. While increased engagement and enjoyment are frequently cited benefits of game-based learning, few studies have directly measured whether such approaches translate into objectively improved technical scores. Therefore, a controlled comparison using pretest and posttest assessments is necessary to determine the magnitude of improvement attributable to different training modalities.

The present study addresses this gap by employing a quasi-experimental design to compare the effects of Drill Practice and Game-Based Practice on Kumite Gyaku Tsuki performance among vocational high school students participating in extracurricular Karate. Performance was evaluated using standardized scoring criteria by licensed national referees, thereby enhancing ecological validity and aligning assessment with authentic Karate evaluation standards. By isolating a single, clearly defined technique, this study seeks to provide a more precise understanding of how practice design influences measurable technical outcomes (X. Li et al., 2024; Parsamajd & Teymori, 2024; Zhao et al., 2024).

The novelty of this research lies in its focused examination of a specific striking technique within a school-based extracurricular context, combined with a direct statistical comparison between conventional Drill Practice and Game-Based Practice. Unlike broader investigations of youth motor development, this study narrows its scope to a defined technical skill and evaluates performance using formal scoring metrics. In doing so, it contributes to ongoing discussions in sport science regarding effective pedagogical strategies in martial arts education (Longa, 2025; Rozi et al., 2025).

In summary, this study aims to determine whether Game-Based Practice provides superior improvements in Kumite Gyaku Tsuki performance compared to traditional Drill Practice, and to quantify the magnitude of these effects. By situating the investigation within a real school extracurricular setting, this research contributes empirical evidence to the development of training models that balance technical excellence and student engagement in martial arts education (Azab et al., 2022; Doder et al., 2022).

Method

This study employed a quasi-experimental pretest–posttest control group design to examine the effects of Drill Practice and Game-Based Practice on Kumite Gyaku Tsuki technique performance. A true experimental design was not feasible because participants were drawn from an existing extracurricular Karate program, and administrative constraints did not allow full randomization. However, efforts were made to ensure comparability between groups prior to intervention.

Participants consisted of 31 male grade-10 students enrolled in the extracurricular Karate program at SMK Negeri 1 Bintan Utara. Inclusion criteria included active participation in the program for at least three months and regular attendance (minimum 85%) during the intervention period. Participants had beginner to intermediate belt levels (white to green belt), ensuring relatively similar technical backgrounds. Based on pretest scores, participants were assigned into two groups with comparable mean baseline performance: an experimental group ($n = 16$) and a control group ($n = 15$). Independent t-test analysis of pretest scores confirmed no significant difference between groups at baseline ($p > 0.05$), indicating initial equivalence in skill level.

The intervention was conducted over 16 training sessions from November 2025 to January 2026, with two sessions per week. Each session lasted 90 minutes and followed a standardized structure: 15 minutes of warm-up, 60 minutes of core training, and 15 minutes of cool-down. Both groups received identical warm-up and cool-down activities to control for physical conditioning effects, and training was delivered by the same instructor to minimize instructional bias.

The control group received conventional Drill Practice, defined as repetitive, instructor-led execution of Gyaku Tsuki in stationary and step-forward formats under controlled conditions. Training emphasized correct stance (zenkutsu-dachi), hip rotation, punching trajectory, kime (focus), and balance stabilization. Feedback was primarily corrective and technique-oriented.

The experimental group received a combination of structured Drill Practice (to maintain technical fidelity) and Game-Based Practice. The game-based component embedded Gyaku Tsuki execution within modified sparring scenarios, reaction-based challenges, target-based scoring games, and timed competitive drills. These activities required students to execute Gyaku Tsuki under situational constraints such as movement cues, opponent simulation, or point-based objectives. The proportion of drill and game-based elements was approximately 50:50 within the core training segment.

The dependent variable, Kumite Gyaku Tsuki technique performance, was operationally defined as the quality of execution of the reverse punch assessed across four components: speed, power, accuracy, and body stability. Performance testing was conducted under standardized conditions. Each participant performed five Gyaku Tsuki attempts toward an official target area under referee supervision, and the three best attempts were scored.

Assessment was carried out by three certified national Karate referees who were blinded to group allocation to reduce evaluation bias. Scoring was based on adapted Kumite criteria derived from Sanbon, Nihon, and Ippon standards, converted into a numerical scale ranging from 0 to 50. Inter-rater reliability was examined using intraclass correlation coefficients (ICC), demonstrating high agreement among referees ($ICC > 0.80$). The average score of the three referees was used as the final performance score.

Pretest measurements were conducted one week before the intervention. Posttest measurements were conducted after the 16th training session under identical testing conditions. Although formative evaluations were conducted during the midpoint of the program for monitoring purposes, only pretest and final posttest data were included in the statistical analysis to maintain clarity of comparison.

Data analysis was performed using descriptive and inferential statistics. Normality assumptions were tested using the Shapiro–Wilk test, and homogeneity of variances was examined using Levene’s test. Within-group improvements were analyzed using paired sample t-tests. Between-group differences were analyzed using independent sample t-tests on both posttest scores and gain scores (posttest minus pretest). Statistical significance was set at $\alpha = 0.05$. In addition to p-values, effect sizes (Cohen’s d) were calculated to determine the magnitude of the intervention effects.

Attendance was monitored throughout the intervention, and only participants who completed all testing sessions and attended at least 85% of training sessions were included in the final analysis. Ethical approval was obtained from the school administration, and informed consent was secured from participants and their parents prior to data collection. Participation was voluntary, and confidentiality of individual data was maintained. Through these methodological controls, the study aimed to ensure internal validity while maintaining ecological validity within the natural setting of a school extracurricular Karate program.

Results and Discussions

The present study aimed to investigate the effect of Drill Practice and Game-Based Practice on the Kumite Gyaku Tsuki technique skills among extracurricular Karate students at SMK Negeri 1 Bintan Utara. A total of 31 male students participated and were divided into two groups: an experimental group ($n = 16$) receiving Game-Based Practice and a control group ($n = 15$) receiving Drill Practice. Data were collected using pretest and posttest measurements, and statistical analyses were conducted to examine improvements within groups and differences between groups. Overall, the results indicate that both Drill and Game-Based Practice significantly improve Kumite Gyaku Tsuki skills, with the experimental group showing higher posttest scores compared to the control group.

Descriptive Statistics

Table 1. Experimental Group (Game-Based Practice)

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Pretest_Experimental	16	14.00	29.00	19.13	4.29
Posttest_Experimental	16	27.00	51.00	42.13	6.30

The experimental group showed an increase in mean scores from 19.13 in the pretest to 42.13 in the posttest. The relatively low standard deviation in the pretest (4.29) indicates that students’ initial skill levels were fairly homogeneous. After the Game-Based Practice, the posttest standard deviation increased to 6.30, suggesting some variability in skill improvement among students, but the overall enhancement in performance was substantial.

Table 2. Descriptive statistics for the control group

Variable	N	Minimum	Maximum	Mean	Std. Deviation
Pretest_Control	15	14.00	28.00	18.20	4.05
Posttest_Control	15	26.00	43.00	33.47	5.62

The control group also exhibited improvements, with the mean score increasing from 18.20 in the pretest to 33.47 in the posttest. Standard deviations indicate that although students started at similar skill levels ($SD = 4.05$), the variation in posttest scores ($SD = 5.62$) reflects differences in individual progress.

Normality and Homogeneity Tests

All data were normally distributed according to Kolmogorov–Smirnov and Shapiro–Wilk tests ($p > 0.05$), and variances between groups were homogeneous (Levene’s test, $p = 0.347$), meeting the assumptions for parametric testing.

Hypothesis Testing

The paired t-test shows a significant improvement in the experimental group after Game-Based Practice ($p < 0.05$), indicating that the intervention substantially enhanced Kumite Gyaku Tsuki skills.

Table 3. Paired t-test results for the experimental group

Pairing	Mean Difference	t	df	Sig. (2-tailed)
Pretest – Posttest Experimental	-23.00	-17.18	15	0.000

Table 4. Independent t-test results comparing experimental and control groups.

Variable	t	df	Sig. (2-tailed)	Mean Difference	95% CI of Difference
Kumite Gyaku Tsuki Skills	5.907	29	0.000	11.26	7.36 – 15.16

The independent t-test results indicate a significant difference between groups ($p < 0.05$), with the experimental group achieving higher posttest scores than the control group. This demonstrates that Game-Based Practice, combined with Drill Practice, is more effective than conventional Drill Practice alone in improving Kumite Gyaku Tsuki technique skills.

The findings of this study indicate that both Drill Practice and Game-Based Practice significantly improved Kumite Gyaku Tsuki performance among extracurricular Karate students. However, beyond statistical significance, it is important to interpret these results within a motor learning framework. The substantial increase in scores in both groups confirms that structured, repeated exposure to technique execution remains fundamental in early-stage skill acquisition (Giardullo et al., 2025; Giuseppe et al., 2025). Repetition likely strengthened neuromuscular coordination, timing, and movement consistency, which are essential components of Gyaku Tsuki performance.

The greater improvement observed in the experimental group suggests that embedding technical execution within interactive and situational tasks may enhance learning efficiency. From a motor learning perspective, Game-Based Practice may introduce contextual interference and variability of practice, requiring learners to adapt their punching mechanics under dynamic constraints. Such conditions potentially stimulate more robust motor encoding compared to repetitive drills alone. This interpretation aligns with previous findings indicating that interactive and dynamic training formats can improve both performance outcomes and learner engagement (Adirahma, Widiyanto, Setyawan, Hamsyah, Darmawan, Nurkadri, Novita, Safrudin, HB, et al., 2024; Afifah et al., 2025).

Biomechanically, Gyaku Tsuki requires coordinated hip rotation, lower-limb stabilization, trunk acceleration, and precise arm extension. Practicing the technique within game-like scenarios may have enhanced not only mechanical repetition but also timing, reaction speed, and postural adjustment under simulated competitive pressure. While the present study did not directly measure biomechanical variables, the higher posttest scores in the experimental group suggest that contextualized practice may have facilitated more integrated execution of these components.

Nevertheless, the slightly higher posttest standard deviation in the experimental group indicates variability in individual responses to Game-Based Practice. This variability may reflect differences in prior experience, adaptability to dynamic learning environments, or intrinsic motivation. However, it is important to note that motivation and engagement were not directly measured in this study; therefore, interpretations regarding psychological mechanisms remain inferential rather than empirically confirmed (Hausen et al., 2021; Sumaraw et al., 2025). Future research incorporating validated motivation scales would help clarify whether engagement mediates technical improvement.

The significant independent t-test results demonstrate that the experimental group outperformed the control group at posttest. However, caution is necessary when interpreting superiority. Although the gain scores were higher in the Game-Based group, the quasi-experimental design limits full causal inference. Despite baseline equivalence, unmeasured factors such as individual learning preferences or peer interaction effects may have contributed to performance differences. Additionally, the novelty of game-based activities may have temporarily increased enthusiasm, potentially amplifying short-term performance gains.

The improvement observed in the control group confirms that traditional Drill Practice remains an effective method for developing fundamental Karate techniques. Repetition reinforces motor pathways and refines technical precision. However, drills alone may provide limited exposure to decision-making demands or reaction-based adjustments that characterize real Kumite situations. In this context,

Game-Based Practice may offer added value by integrating cognitive and situational elements into technical execution (Gavagan, n.d.; Prasetyo et al., 2025).

It is also important to consider the possibility of testing effects, as participants performed similar evaluation procedures in both pretest and posttest sessions. Familiarity with the assessment format may have contributed to score improvements in both groups. Furthermore, because performance was evaluated through referee-based scoring, subtle evaluator bias cannot be entirely ruled out, even though standardized criteria were applied.

From a practical standpoint, the findings suggest that combining structured drills with game-based elements may optimize training efficiency in school-based extracurricular settings. Such environments often involve limited training time and heterogeneous student ability levels, making engagement and instructional efficiency critical (Adirahma, Widiyanto, Setyawan, Hamsyah, Darmawan, Nurkadri, Novita, Safrudin, Gusliana, et al., 2024; Permatasari et al., 2024). However, instructors should consider contextual factors such as class size, cultural expectations within traditional martial arts practice, and available resources before implementing game-based models extensively.

Several limitations must be acknowledged. The sample size was relatively small and limited to male vocational high school students, which restricts generalizability to female students, different age groups, or competitive athletes. The intervention duration was limited to 16 sessions, and long-term retention of skill improvements was not assessed. Moreover, psychological variables such as motivation, enjoyment, and perceived competence were not measured, limiting the ability to explain underlying mechanisms. Finally, although the study isolated a single technique for precision, broader performance indicators such as actual competitive outcomes were not examined.

Despite these limitations, the study contributes empirical evidence to discussions on pedagogical innovation in martial arts training. By isolating a specific striking technique and applying standardized referee-based assessment, this research extends previous work that primarily focused on general motor development (Azab et al., 2022; Doder et al., 2022). The findings support the perspective that integrating interactive and context-rich activities into technical practice may enhance skill acquisition without abandoning the foundational value of repetitive drills.

Future research should examine long-term retention effects, include psychological mediators such as intrinsic motivation and engagement, and explore the applicability of combined training approaches to other Karate techniques or martial arts disciplines. Additionally, experimental designs with larger and more diverse samples would strengthen causal inference and expand the generalizability of findings.

In conclusion, while Drill Practice remains essential for foundational technical refinement, the integration of Game-Based Practice appears to provide additional benefits in improving Kumite Gyaku Tsuki performance within a school extracurricular context. A balanced pedagogical approach that combines repetition with contextualized interaction may represent an effective strategy for enhancing both technical excellence and meaningful engagement in martial arts education.

Conclusions

Drill and Game-Based Practice significantly improve the Kumite Gyaku Tsuki technique skills of extracurricular Karate students, with game-based methods demonstrating greater effectiveness than conventional training. These findings indicate that incorporating interactive and engaging training approaches enhances skill acquisition, motivation, and overall performance in Karate students.

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