



Instructional Models and Self-efficacy in Karate Training: A Factorial Study of Kumite Skill Development

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Abstract

This research was conducted to investigate the influence of instructional models and self-efficacy on the development of kumite technique skills in karate practice. An experimental approach with a 2×2 factorial design was implemented. The instructional model served as the independent variable, comprising Direct Instruction (DI) and the Personalized System for Instruction (PSI), while self-efficacy was treated as a moderating variable. The participants included 32 students involved in a karate extracurricular activity at a public senior high school in Bandung Regency. The assessment of kumite technique performance was carried out using the System for the Technical Assessment of Kumite (STAK). In contrast, students' self-efficacy levels were measured through the General Self-Efficacy Scale (GSES-12). The collected data were examined using two-way ANOVA. The analysis revealed that the instructional model significantly affected the enhancement of kumite technique skills. Self-efficacy was also found to have a significant impact on the improvement of kumite performance. Moreover, a statistically significant interaction emerged between the instructional model and self-efficacy. These results suggest that the application of Direct Instruction combined with a high level of self-efficacy resulted in the greatest improvement in kumite technique skills.

Keywords: *Self-Efficacy, Karate, Instructional Model*

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INTRODUCTION

Education plays a crucial role in fostering the holistic development of students, encompassing cognitive, physical, social, and emotional dimensions (Bhowmik & Choudhury, 2017). Within the context of physical education, learning is not only directed toward improving physical fitness and motor competence but also toward shaping character and psychological resilience. One of the sports increasingly implemented in school-based physical education and extracurricular activities is karate. As a martial art, karate contains educational values such as discipline, courage, emotional control, and cooperation, which contribute to students' personal development (Cynarski, 2017; Isnaeni, 2019). In addition to improving physical strength and coordination, karate training has been shown to enhance psychological attributes such as self-discipline, emotional regulation, and self-confidence (Greco et al., 2019; Piepiora, 2025).

These characteristics position karate as an educational activity that supports both physical competence and psychological development in students (Herdiansyah et al., 2025).

Among the various components of karate practice, kumite represents one of the most complex learning domains because it requires the integration of technical, cognitive, and psychological abilities. Unlike *kihon*, which focuses on fundamental techniques, and *kata*, which emphasizes structured movement sequences, kumite involves direct interaction with an opponent in dynamic and unpredictable situations (Piepiora et al., 2016; Simões et al., 2024). Performance in kumite depends not only on technical accuracy but also on timing, distance control, reaction speed, and mental readiness (*zanshin*). Various forms of kumite practice, from structured drills such as *ippon kumite* to free sparring such as *jiyu kumite*, are designed to facilitate the transfer of motor skills from controlled training situations to real performance contexts (Alcaraz et al., 2008). Consequently, effective instruction is essential to ensure that students are able to develop the technical and cognitive competencies required in kumite performance.

However, learning practices in many school-based martial arts programs still tend to emphasize repetitive technical drills without adequately considering students' psychological characteristics. As a result, students may experience difficulties in mastering techniques, particularly when learning complex open skills such as kumite. Previous research suggests that the effectiveness of motor skill learning is strongly influenced by instructional strategies and learner characteristics (Casey & Kirk, 2020). In this regard, the selection of appropriate instructional models becomes a key factor in optimizing skill acquisition in physical education settings.

Two instructional approaches that are widely discussed in sport pedagogy are Direct Instruction (DI) and the Personalized System for Instruction (PSI). DI emphasizes structured teaching procedures involving explicit explanation, demonstration, guided practice, and immediate feedback (Guzmán & Payá, 2020; Metzler, 2017). Systematic instructional sequences such as reviewing prior knowledge, presenting new material, guiding practice, and providing feedback have been shown to enhance learning efficiency and improve motor skill accuracy (Rosenshine, 2012). Demonstrations and visual modeling also facilitate the acquisition of movement patterns by allowing learners to observe and replicate correct techniques (Schmidt & Lee, 2014). In contrast, the PSI promotes learner autonomy through self-paced, modular learning and mastery-based progression, enabling students to repeat learning units until the required level of competence is achieved (Hannon et al., 2008; Mannion et al., 2023).

In addition to instructional strategies, psychological factors also play an important role in motor skill learning. Social cognitive theory highlights the concept of self-efficacy, defined as individuals' beliefs in their ability to successfully perform specific tasks (Bandura, 1997, 2013). In sport and motor learning contexts, students with high self-efficacy tend to demonstrate greater persistence, confidence, and engagement when facing challenging tasks, whereas those with lower self-efficacy may experience hesitation and reduced motivation (López-Rodríguez et al., 2025; Schunk & DiBenedetto, 2020). Therefore, self-efficacy may influence how students respond to different instructional approaches during skill acquisition.

Although previous studies have examined instructional models and psychological factors separately, empirical research that simultaneously investigates the interaction between instructional models and self-efficacy in martial arts learning remains limited. Most studies focus on general physical education contexts rather than specific sport skills such as kumite, which involve complex open-skill characteristics and rapid decision-making processes. Addressing this gap is important because the effectiveness of instructional models may vary depending on students' psychological characteristics. Therefore, this study aims to examine the effects of DI and the PSI on students' kumite technique skills and to investigate the moderating role of self-efficacy in this relationship. The findings of this study are expected to contribute to the development of sport pedagogy by providing empirical evidence regarding the integration of instructional strategies and psychological factors in karate learning contexts.

METHOD

Study Design

This study employed an experimental approach using a 2×2 factorial design to examine the effects of instructional models and self-efficacy on kumite technique skills. In this design, the instructional model served as the independent variable (A). At the same time, self-efficacy functioned as the moderating variable (B), and kumite technique skill was treated as the dependent variable. The instructional model consisted of DI (A₁) and the PSI (A₂). Meanwhile, self-efficacy was categorized into high (B₁) and low (B₂) groups. The factorial design enabled the analysis of both the main effects of each variable and their interaction effect on kumite technique performance (Fraenkel et al., 2023).

Table 1. Two-way factorial design

Sel-efficacy (B)	Instructional Models	
	DI (A ₁)	PSI (A ₂)
High (B ₁)	A ₁ B ₁	A ₂ B ₁

Low (B ₂)	A ₁ B ₂	A ₂ B ₂
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Participants

The participants in this study were students involved in the karate extracurricular program at a public senior high school located in Bandung Regency, Indonesia, during the 2024/2025 academic year. The total population comprised 60 students who consistently attended karate training sessions. From this population, participants were selected through purposive sampling based on predetermined research criteria, namely active involvement in karate extracurricular practice and the capability to execute kumite techniques (Fraenkel et al., 2023).

The participants were subsequently grouped according to their levels of self-efficacy, categorized as high and low based on their scores using the 27% upper-lower proportion method (Miller, 2008; Sumaraw et al., 2025). Students whose scores fell within the highest 27% were assigned to the high self-efficacy group, whereas those within the lowest 27% were classified as the low self-efficacy group. Individuals whose scores were positioned within the middle range were excluded from further analysis. Through this procedure, a total of 32 participants were obtained, consisting of 16 students in the high self-efficacy category and 16 students in the low self-efficacy category. Following this classification, participants were allocated to the treatment groups using an ordinal pairing technique (Sucipto & Widiyanto, 2016).

Instruments

Two instruments were used to collect data in this study: a self-efficacy questionnaire and a performance-based assessment of kumite technique skills. Students' self-efficacy was measured using the General Self-Efficacy Scale (GSES-12). The instrument consists of 12 statements that evaluate students' confidence in managing difficult situations, completing tasks, and maintaining persistence when facing obstacles. Responses were recorded using a Likert-type scale, and the total score represented each student's level of self-efficacy (Soetjipto et al., 2023).

Kumite technique skills were measured using the System for the Technical Assessment of Kumite (STAK) (Ferreira et al., 2024). This instrument evaluates four common kumite techniques, namely *kizami-zuki*, *gyaku-zuki*, *mawashi-geri*, and *ura-mawashi-geri*. Each technique is assessed using four evaluation criteria: good form, vigorous application, martial attitude (*zanshin*), and correct distance. Each criterion is rated on a three-point scale to determine the quality of technique execution. The assessment was conducted by two karate

experts with at least DAN II black belt certification and experience as kumite referees. Inter-rater reliability of the instrument was examined using the Intraclass Correlation Coefficient (ICC) to ensure consistency in scoring across raters.

Procedures

The research was conducted through pretest and posttest procedures. Initially, participants completed a self-efficacy questionnaire to determine their classification into high and low self-efficacy groups. A pretest of kumite technique skills was then conducted using the STAK.

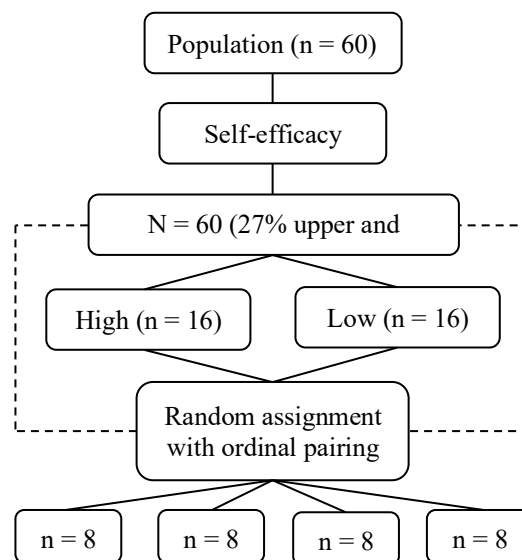


Figure 1. The flow of treatment group assignments

The intervention was implemented during regular karate training sessions over several weeks according to the extracurricular schedule. Participants in the DI group received structured instruction consisting of teacher explanations, demonstrations, guided practice, and immediate feedback. In contrast, participants in the PSI group followed modular learning materials that allowed students to progress at their own pace through mastery-based learning principles. After the intervention period, a posttest was conducted using the same assessment procedure as the pretest to measure changes in kumite technique performance.

Instructional Treatment

The instructional intervention was implemented following the administration of the pretest and the measurement of students' self-efficacy levels. The treatment consisted of 10 instructional sessions conducted over approximately six weeks within the karate

extracurricular training schedule. Each session focused on the development of kumite technique skills in karate.

The DI model emphasized structured and teacher-centered instruction. In this model, the instructor first explained the learning objectives and demonstrated the correct execution of kumite techniques. Students then practiced the techniques through guided practice while receiving immediate feedback and corrections from the instructor. The learning process followed a sequential structure consisting of explanation, demonstration, guided practice, and independent practice to ensure accurate mastery of the techniques.

In contrast, the PSI emphasized self-paced learning and individual mastery. Students were provided with instructional materials and task modules containing kumite technique exercises. Participants were allowed to practice the techniques independently and progress through the learning tasks according to their own learning pace. The instructor functioned primarily as a facilitator who monitored students' progress and provided feedback when necessary. Students were encouraged to repeat the learning tasks until they achieved the expected level of mastery.

Each training session was conducted using a similar general structure. The session began with a warm-up phase, followed by the main practice session focusing on kumite techniques, and ended with a cool-down phase. The kumite techniques practiced during the intervention included *kizami-zuki*, *gyaku-zuki*, *mawashi-geri*, and *ura-mawashi-geri*, which represent commonly used techniques in kumite performance. After the completion of all treatment sessions, a posttest was administered using the same assessment procedure as the pretest to evaluate the improvement of students' kumite technique skills.

Statistical Analysis

The statistical procedures were carried out with the assistance of IBM SPSS version 29. Initially, descriptive statistical measures were generated to summarize the overall characteristics of the dataset. The normality of the score distribution was evaluated using the Shapiro-Wilk test, which is widely regarded as suitable for datasets with relatively limited sample sizes. In addition, Levene's test was implemented to assess the equality of variances across the comparison groups.

Once these assumptions were confirmed, the main analysis proceeded using a two-way analysis of variance (ANOVA) to investigate the influence of instructional models, levels of self-efficacy, and the interaction between these variables on kumite technique skills. When the ANOVA results indicated statistically significant differences, Tukey's post hoc test was

subsequently employed to determine which specific treatment groups differed from one another. All statistical decisions in this study were evaluated using a significance threshold of $\alpha = 0.05$.

RESULTS AND DISCUSSION

Results

Descriptive statistics were calculated to provide an overview of the improvement in kumite technique skills across the experimental groups. The improvement in students' performance was analyzed using the normalized gain score (N-gain), which represents the relative increase in performance from pretest to posttest (Hake, 1998; Nissen et al., 2018). The descriptive results show variations in improvement among the four treatment groups formed by the combination of instructional models and self-efficacy levels. The descriptive results indicate that the DI model combined with high self-efficacy produced the highest improvement, while the lowest improvement occurred in the DI group with low self-efficacy.

Table 2. Descriptive statistics of N-gain scores for kumite technique skills

Group	N	Mean	SD	Total
A1B1 (DI - High Self-efficacy)	8	0.63	0.12	5.05
A2B1 (PSI - High Self-efficacy)	8	0.37	0.15	2.95
A1B2 (DI - Low Self-efficacy)	8	0.33	0.11	2.61
A2B2 (PSI - Low Self-efficacy)	8	0.39	0.13	3.08

Prior to performing the two-way ANOVA, preliminary tests were carried out to verify that the dataset fulfilled the assumptions required for parametric statistical procedures, specifically normality and homogeneity of variance. The normality assessment indicated that the significance values for both instructional model groups exceeded 0.05, demonstrating that the distribution of the data could be considered normal. Furthermore, the Levene's test results produced a significance value greater than 0.05, suggesting that the variances across the groups were equivalent. These findings confirmed that the dataset met the necessary conditions to proceed with the two-way ANOVA analysis.

The outcomes are summarized in Table 3. The analysis indicated that the instructional model significantly influenced the improvement of kumite technique skills ($p < 0.05$). In addition, the level of self-efficacy was also found to have a statistically significant effect on the enhancement of kumite technique performance ($p < 0.05$). Moreover, a significant

interaction effect was identified between instructional model and self-efficacy, implying that the impact of the instructional model varied according to the students' level of self-efficacy.

Table 3. Normality and homogeneity testing

Normality Test (Shapiro-Wilk)				Homogeneity Test (Levene's)			
Group	Statistic	df	p	F	df	p	
DI	0.917	16	0.149	0.844	3, 28	0.481	
PSI	0.908	16	0.107				

Table 4. Results of Two-Way ANOVA for the Effects of Instructional Model (A) and Self-Efficacy (B) on Kumite Technique Skills

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	0.456	3	0.152	9.383	<0.001	0.501
Intercept	5.857	1	5.857	361.399	<0.001	0.928
A	0.083	1	0.083	5.123	0.032	0.155
B	0.167	1	0.167	10.290	0.003	0.269
A × B	0.206	1	0.206	12.736	0.001	0.313
Error	0.454	28	0.016			
Total	6.767	32				
Corrected Total	0.910	31				

Note: $R^2 = 0.501$ (Adjusted $R^2 = 0.448$)

The findings of the statistical analysis indicated that the instructional model significantly influenced kumite technique skills ($F = 5.123$, $p = 0.032$). This outcome suggests that the level of improvement in kumite technique performance differed meaningfully between students who were taught using the DI model and those who received instruction through the PSI model.

The results further demonstrated that self-efficacy had a statistically significant effect on kumite technique skills ($F = 10.290$, $p = 0.003$). Students who possessed higher levels of self-efficacy exhibited greater improvements in their kumite technique skills compared with students whose self-efficacy levels were lower. In addition, the analysis revealed a significant interaction between the instructional model and self-efficacy ($F = 12.736$, $p = 0.001$). This finding indicates that the effectiveness of the instructional model varied depending on the

students' level of self-efficacy. Overall, the regression model accounted for 50.1% of the variance in the improvement of kumite technique skills ($R^2 = 0.501$).

Hypothesis 1

The first hypothesis tested whether there was a significant difference in kumite technique skill improvement between students who learned using the DI model and those who learned using the PSI model. The results of the two-way ANOVA analysis showed that the instructional model had a significant effect on kumite technique skills ($F = 5.123$, $p = 0.032$). These findings indicate that the improvement in kumite technique skills differed significantly between students who received the DI model and those who received the PSI model.

Hypothesis 2

The second hypothesis examined whether there was a significant difference in kumite technique skill improvement between students with high self-efficacy and those with low self-efficacy. The results of the two-way ANOVA analysis revealed that self-efficacy had a significant effect on kumite technique skills ($F = 10.290$, $p = 0.003$). This result indicates that students with different levels of self-efficacy demonstrated different levels of improvement in kumite technique skills.

Hypothesis 3

The third hypothesis examined the presence of an interaction between the instructional model and self-efficacy in influencing kumite technique skills. The two-way ANOVA results indicated that the interaction between these variables was statistically significant ($F = 12.736$, $p = 0.001$). This outcome suggests that the impact of the instructional model on the improvement of kumite technique skills differed according to the students' levels of self-efficacy. The pattern of interaction between instructional model and self-efficacy is presented in Figure 2.

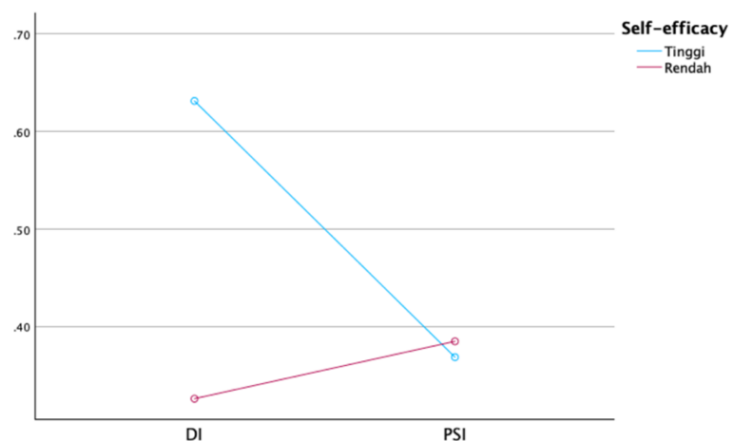


Figure 2. Interaction effect between instructional model and self-efficacy on kumite technique skills

Hypothesis 4

The fourth hypothesis examined whether there were significant differences in kumite technique skill improvement among the four treatment groups (A_1B_1 , A_2B_1 , A_1B_2 , and A_2B_2). Based on the descriptive statistics of N-gain scores, the A_1B_1 group (DI with high self-efficacy) demonstrated the highest improvement in kumite technique skills ($M = 0.63$), followed by A_2B_2 (PSI with low self-efficacy) ($M = 0.39$), A_2B_1 (PSI with high self-efficacy) ($M = 0.37$), and A_1B_2 (DI with low self-efficacy) ($M = 0.33$). These results indicate that the combination of instructional model and self-efficacy level influenced the improvement of kumite technique skills across treatment groups.

Discussion

The findings of this study indicate that the instructional model significantly influenced the improvement of students' kumite technique skills. Students who learned through the **DI model** demonstrated greater improvement compared with those who received the **PSI model**. This finding suggests that structured instructional procedures involving clear explanations, demonstrations, guided practice, and immediate feedback contribute more effectively to the development of technical skills in karate kumite (Stockard et al., 2018). DI allows instructors to organize learning activities systematically and provide corrective feedback during practice, which is essential in the acquisition of complex motor skills (Sierra-Ríos et al., 2020). These results are consistent with the perspective that effective instruction requires clear presentation of material followed by guided practice and feedback to support learning outcomes (Rosenshine, 2012). In motor skill learning contexts, demonstrations and feedback are also important for helping learners understand correct movement patterns and refine their technical performance (Schmidt & Lee, 2014).

The results also revealed that self-efficacy had a significant effect on the improvement of kumite technique skills. Students with higher levels of self-efficacy demonstrated greater improvement compared with students who had lower levels of self-efficacy. This finding supports the principles of social cognitive theory, which emphasize that individuals' beliefs about their capabilities influence their motivation, persistence, and performance when facing challenging tasks (Bandura, 1997). Students with strong self-efficacy tend to approach learning tasks with greater confidence and persistence, enabling them to maintain effort during repeated practice activities (Bandura, 2013; Trautner & Schwinger, 2020). As a result, they are more likely to engage actively in training sessions and demonstrate higher performance improvement. Previous research also indicates that learners with stronger self-efficacy

generally show greater commitment and persistence in completing learning tasks (Schunk & DiBenedetto, 2020).

Furthermore, the study identified a significant interaction between instructional model and self-efficacy in influencing kumite technique skill improvement. The interaction pattern showed that students with high self-efficacy achieved the greatest improvement when learning through the DI model, whereas students with low self-efficacy demonstrated relatively better improvement when learning through the PSI model. This finding suggests that the effectiveness of instructional strategies may depend on students' psychological characteristics, particularly their confidence in performing specific tasks (Abbas & North, 2018; Peng & Zhang, 2021).

The dominance of the DI model among students with high self-efficacy may also be explained by the nature of karate training, which emphasizes discipline, adherence to instructor guidance, and repetitive practice of technical movements (Cynarski, 2017; de Lima Amaral et al., 2022). In such training environments, students with strong confidence in their abilities are more capable of responding to structured instruction and performing techniques with greater accuracy and consistency (Light & Eckford, 2025). These findings provide practical implications for karate instructors in selecting instructional strategies that align with students' psychological characteristics, particularly self-efficacy. However, this study was limited to students participating in a school karate extracurricular program, which may restrict the generalization of the findings to other sports contexts. Therefore, future research is recommended to examine similar instructional approaches in broader sport settings and different levels of athletic experience.

CONCLUSION

This study concludes that both the instructional model and students' self-efficacy significantly influence the improvement of kumite technique skills. The results indicate that the DI model produced greater improvement in kumite technique skills compared with the PSI model. In addition, students with high self-efficacy demonstrated higher skill improvement than those with low self-efficacy. The findings also revealed a significant interaction between instructional model and self-efficacy, indicating that the effectiveness of instructional strategies depends on students' psychological characteristics. The results highlight that the combination of DI and high self-efficacy produced the highest improvement in kumite technique skills. This finding suggests that structured and instructor-guided learning approaches are particularly effective for students who possess strong confidence in their

abilities, especially in martial arts training environments that emphasize discipline, technical precision, and repetitive practice.

These findings contribute to the development of sport pedagogy and martial arts training practices by demonstrating the importance of aligning instructional strategies with students' psychological characteristics. For practical applications, karate instructors and physical education teachers are encouraged to consider both instructional models and students' self-efficacy levels when designing learning activities aimed at improving technical performance. Future research is recommended to explore similar instructional approaches in different sport contexts, larger sample sizes, and varying levels of athletic experience to strengthen the generalizability of these findings further.

ACKNOWLEDGMENT

The authors would like to convey their sincere appreciation to all parties and institutions whose support contributed to the successful completion of this study. Particular thanks are addressed to the school management, karate coaches, and students involved in the karate extracurricular activities for their willingness to participate and for the time and cooperation they provided during the entire research process.

The authors also thank the academic supervisors and colleagues who provided valuable guidance, feedback, and encouragement during the development of this study. Their insights and suggestions greatly contributed to improving the quality of this research. Finally, the authors acknowledge the institutional support that facilitated the implementation of this study and the preparation of this manuscript. Their support made it possible for this research to be conducted and disseminated.

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