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AI-Assisted Self-Learning Versus Conventional Demonstration on the Quality of Martial Arts Technique Execution: A Quasi-Experimental Classroom Study

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Abstract. This study investigates the comparative effectiveness of AI-assisted self-learning and conventional demonstration methods in improving the quality of martial arts technique execution among university students. This quasi-experimental classroom study involved 120 students divided into two groups: an experimental group using AI-assisted learning platforms and a control group receiving conventional instructor-led demonstrations. Data were collected through pre-test and post-test assessments using validated rubrics measuring technique accuracy, movement fluidity, speed, and power execution. Independent t-tests and repeated measures ANOVA were employed for statistical analysis. Results demonstrated that the AI-assisted self-learning group achieved significantly higher improvements in technique execution quality ($M = 28.45$, $SD = 4.12$) compared to the conventional demonstration group ($M = 23.67$, $SD = 5.38$), $t(118) = 4.52$, $p < 0.001$, with a large effect size ($d = 0.95$). Furthermore, the AI group showed greater consistency in performance maintenance across multiple trials. These findings suggest that AI-assisted learning provides personalized feedback mechanisms and repetitive practice opportunities that facilitate superior skill acquisition in martial arts training. The study concludes that integrating AI technology into martial arts pedagogy can complement traditional instruction methods and enhance student learning outcomes.

Keywords: AI-assisted learning, martial arts, pedagogical methods, skill execution quality, technology integration

1 Introduction

The advancement of educational technology has fundamentally transformed teaching and learning paradigms across various disciplines, including physical education and martial arts training (Utami et al., 2021). Martial arts, particularly disciplines such as taekwondo, karate, and wushu, have traditionally relied on direct physical demonstration and instructor feedback as primary pedagogical methods (Gunawan & Suharyanto, 2020). However, the emergence of artificial intelligence and machine learning technologies has introduced innovative alternatives

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for skill acquisition and performance enhancement (Firmansyah et al., 2022). The integration of AI-powered platforms in sports training has demonstrated promising results in various contexts, offering real-time performance analysis, personalized feedback, and adaptive learning pathways that can address individual student needs more effectively than conventional group instruction (Wijayanto et al., 2023).

Traditional demonstration-based learning, while establishing the foundation of martial arts pedagogy for centuries, presents several inherent limitations when applied to contemporary educational settings. The conventional approach typically involves an instructor performing a technique while students observe and attempt to replicate the movement, followed by subjective feedback based on the instructor's observation (Hermawan & Hidayat, 2019). This method faces challenges in terms of scalability, as instructors must divide their attention among multiple students simultaneously, potentially resulting in inconsistent quality of instruction and feedback, particularly for students requiring additional support or advanced progression (Ramadhani et al., 2021). Moreover, the acquisition of complex motor skills necessitates substantial practice repetition and corrective feedback, which conventional classroom settings may struggle to provide adequately due to temporal and resource constraints (Santoso et al., 2020).

The pedagogical landscape of martial arts instruction increasingly recognizes the potential of technology-enhanced learning environments to address these limitations. Recent investigations have explored the efficacy of video analysis, motion capture technology, and AI-assisted feedback systems in improving technical proficiency among martial artists (Pranoto et al., 2022). These technologies enable the collection of detailed biomechanical data, allow learners to review their performance repeatedly, and facilitate comparison with expert demonstrations, thereby creating conditions conducive to accelerated learning and performance optimization (Nurdin et al., 2023). Artificial intelligence systems, in particular, can process complex movement patterns, identify deviations from optimal technique, and provide instantaneous, evidence-based feedback that aligns with current understanding of motor learning principles (Budiman et al., 2021).

Despite the growing body of research supporting technology integration in sports pedagogy, empirical comparisons between AI-assisted self-learning and conventional demonstration methods remain limited in the martial arts context, particularly within Indonesian educational settings. Most existing studies have focused on single intervention methods rather than direct comparative analyses that would enable educators to make informed pedagogical decisions (Wijaya et al., 2020). Furthermore, the question of whether AI-assisted learning can achieve superior outcomes compared to established traditional methods remains contested, with some scholars expressing concerns about the depersonalization of instruction and the potential diminishment of the mentor-student relationship inherent in martial arts traditions (Sumarno et al., 2022).

This study addresses these gaps by conducting a rigorous quasi-experimental investigation comparing AI-assisted self-learning and conventional demonstration approaches in developing martial arts technique execution quality. The primary research question guiding this investigation is: To what extent do AI-assisted self-learning and conventional demonstration methods differ in their effectiveness in improving the quality of martial arts technique execution? Secondary questions address the temporal progression of skill development, the consistency and sustainability of performance improvements, and the potential interactions between learning method and individual student characteristics. By systematically examining these comparative outcomes, this research contributes to evidence-based decision-making in

martial arts pedagogy and illuminates the optimal role of technology integration in traditional skill-based disciplines.

2 Method

This research employed a quasi-experimental classroom design with non-random assignment of participants to control and experimental groups. The study was conducted at a state university in Indonesia over a 12-week period during the academic year 2023-2024. Participants comprised 120 undergraduate students (ages 19-24 years; 68 male, 52 female) enrolled in martial arts elective courses. Two intact classes were assigned to either the conventional demonstration group (n = 60) or the AI-assisted self-learning group (n = 60). The selection of intact classes rather than random individual assignment was necessary due to institutional scheduling constraints and pedagogical considerations. Inclusion criteria required participants to have no prior formal martial arts training and to maintain consistent attendance throughout the study period. Students with documented motor impairments or physical disabilities that would contraindicate participation in martial arts training were excluded from analysis. Informed consent was obtained from all participants prior to data collection, and the research protocol received approval from the university's institutional review board.

The experimental group participated in AI-assisted self-learning using a commercial martial arts training platform integrated with motion recognition algorithms and real-time biofeedback systems. This platform utilized depth-sensing cameras and artificial intelligence models trained on expert martial artist demonstrations to analyze student movements. The system provided instantaneous corrective feedback regarding body alignment, limb trajectory, temporal aspects of movement execution, and overall movement quality. Students completed weekly structured practice sessions of 90 minutes, supplemented with optional self-directed practice time. The platform maintained detailed performance records, tracked progress metrics, and recommended individualized exercises targeting specific technical deficiencies. Students could review their recorded performances multiple times, observe comparisons with expert demonstrations, and track quantitative improvements across dimensions such as accuracy and speed.

The control group received conventional instructor-led demonstration sessions conducted by the same martial arts instructor who had five years of professional teaching experience. These sessions followed traditional pedagogical approaches involving direct physical demonstration of techniques, group practice with instructor observation, and personalized corrective feedback provided by the instructor during practice intervals. The conventional group also participated in weekly 90-minute sessions matching the frequency and duration of experimental group sessions. The instructor provided feedback based on visual observation and professional judgment, following established pedagogical protocols commonly employed in martial arts instruction.

Technique execution quality was assessed using a comprehensive standardized assessment rubric developed collaboratively by three senior martial arts instructors and two sports science researchers. The rubric evaluated four primary dimensions: technique accuracy (assessing whether performed movements matched established technical standards), movement fluidity (evaluating the smoothness and coordinated quality of movement sequences), execution speed (measuring the velocity at which techniques were performed), and power expression (assessing the force and energy generation evident in technique execution). Each dimension was evaluated

on a 10-point scale with detailed descriptors for each performance level. The rubric demonstrated strong inter-rater reliability (intraclass correlation coefficient = 0.89) and test-retest reliability (r = 0.91). Three trained assessors blind to group assignment, independently rated video recordings of participant performances at baseline, mid-intervention (week 6), and post-intervention (week 12) timepoints.

Participants performed a standardized five-technique sequence previously selected and approved by the research team. All recordings were conducted in a controlled gymnasium environment with standardized lighting, camera positioning, and distance to ensure consistency in video quality across all participants and timepoints. Each participant performed the technique sequence three times at each assessment point, and the average score across the three trials was used for analysis.

Descriptive statistics were computed for all variables, including means, standard deviations, and frequency distributions. Preliminary analyses examined group equivalence at baseline using independent samples t-tests for continuous variables and chi-square tests for categorical variables. Homogeneity of variance assumptions were evaluated using Levene's test. The primary hypothesis regarding differences in post-intervention technique quality was tested using independent samples t-tests comparing the two groups on the total rubric scores. Effect sizes were calculated using Cohen's d statistic, with values interpreted as small (d = 0.20), medium (d = 0.50), and large (d = 0.80). Repeated measures ANOVA was employed to examine trajectory of skill development across the three assessment timepoints, with group as the between-subjects factor. Potential moderating effects of baseline skill level and participant gender were explored through factorial ANOVA and regression analysis. All statistical tests employed two-tailed hypothesis tests with alpha = 0.05 as the significance criterion. IBM SPSS version 26.0 was used for all quantitative analyses.

3 Result

The study retained 118 of 120 enrolled participants (two participants withdrew due to health-related reasons unrelated to the study interventions). The final sample comprised 118 students (67 male, 51 female) with mean age of 20.4 years (SD = 1.8). Comparison of baseline characteristics revealed no statistically significant differences between groups on demographic variables or baseline technique execution scores. The conventional demonstration group (M = 14.23, SD = 2.89) and AI-assisted learning group (M = 14.56, SD = 2.71) demonstrated equivalent pre-intervention technical proficiency, t(116) = 0.73, p = 0.47, d = 0.12. Gender distribution did not differ significantly between groups, $\chi^2(1) = 0.18$, p = 0.67.

The AI-assisted self-learning group achieved significantly higher post-intervention technique execution quality (M = 28.45, SD = 4.12) compared to the conventional demonstration group (M = 23.67, SD = 5.38), t(116) = 4.52, p < 0.001, d = 0.95. This difference represents a large effect size, indicating substantial practical significance beyond statistical significance. The mean improvement from baseline to post-intervention was 13.89 points (98.1% improvement) for the AI group and 9.44 points (66.4% improvement) for the conventional group, t(116) = 3.89, p < 0.001, d = 0.84.

Examination of specific performance dimensions revealed that the experimental group achieved higher scores across all four assessed dimensions. For technique accuracy, the AI group achieved M = 7.34 (SD = 0.87) compared to the conventional group M = 6.12 (SD = 1.23),

t(116) = 5.12, p < 0.001, d = 1.09. For movement fluidity, the AI group scored M = 7.12 (SD = 0.95) versus M = 5.89 (SD = 1.34), t(116) = 4.78, p < 0.001, d = 1.01. Execution speed comparisons showed the AI group at M = 6.78 (SD = 1.11) and conventional group at M = 5.23 (SD = 1.67), t(116) = 5.34, p < 0.001, d = 1.16. For power expression, the AI group attained M = 7.21 (SD = 0.98) and conventional group M = 6.43 (SD = 1.29), t(116) = 3.45, p = 0.001, d = 0.68.

Repeated measures ANOVA examining technique quality across three timepoints (baseline, week 6, post-intervention) revealed a significant main effect for time, F(2, 232) = 127.34, p < 0.001, and a significant group by time interaction, F(2, 232) = 18.92, p < 0.001. The interaction effect indicates differential rates of skill development between groups across the intervention period. At week 6 (midpoint), the AI-assisted group (M = 22.11, SD = 3.67) exceeded the conventional group (M = 18.45, SD = 4.23), t(116) = 4.12, p < 0.001, d = 0.87, demonstrating earlier emergence of performance advantages. The trajectory analysis revealed that the conventional group's rate of improvement decelerated in the second six weeks of intervention, while the AI group maintained consistent improvement rates throughout both intervention phases.

The AI-assisted learning group demonstrated greater consistency in technique execution as measured by lower performance variability across trials. Levene's test indicated significantly lower variance in the experimental group compared to control group, F(1, 116) = 6.78, p = 0.01. The coefficient of variation (CV) for the AI group was 0.14 compared to 0.23 for the conventional group, indicating that the experimental group demonstrated more reliable and stable performance execution.

Factorial ANOVA examining the moderating effect of gender on treatment outcomes revealed no significant main effect for gender, F(1, 114) = 1.23, p = 0.27, nor significant gender by treatment interaction, F(1, 114) = 0.89, p = 0.35. Both male and female participants demonstrated comparable benefits from the AI-assisted learning approach, though within-gender effect sizes were somewhat larger for female participants (d = 1.08) than male participants (d = 0.82).

4 Discussion

The findings of this quasi-experimental classroom study provide compelling evidence that AI-assisted self-learning approaches produce superior outcomes compared to conventional instructor-led demonstration methods in developing martial arts technique execution quality. The large effect size (d = 0.95) associated with the primary outcome comparison substantially exceeds conventional thresholds and indicates that the observed differences possess meaningful practical significance for educators and practitioners considering pedagogical approaches (Cohen et al., 2020). The approximately 30-point percentage advantage in improvement magnitude for the AI-assisted group versus the conventional group suggests that artificial intelligence integration in martial arts pedagogy warrants serious consideration as a complement to or potential replacement for traditional instructional methods in certain contexts.

Several mechanisms likely account for the observed superiority of AI-assisted learning approaches. The provision of instantaneous, objective, data-driven feedback represents a fundamental advantage over subjective instructor observation. Human instructors, despite expertise and professional dedication, maintain inherent limitations in perceptual capacity when

monitoring multiple students simultaneously (Sudarma et al., 2021). The AI system's ability to analyze movement biomechanics frame-by-frame, quantify specific deviations from optimal technique, and translate these objective measures into actionable corrective guidance likely facilitates more precise skill refinement and accelerated learning progression. Furthermore, the temporal immediacy of AI-provided feedback aligns with contemporary motor learning theory emphasizing that corrective information provided shortly after movement execution produces stronger performance enhancements compared to delayed feedback (Prabowo et al., 2023).

The personalization inherent in AI-assisted learning platforms represents another significant mechanistic contributor to superior learning outcomes. Rather than all students receiving identical instruction sequences regardless of their individual learning trajectories, AI systems adaptively adjust practice recommendations, difficulty progression, and feedback emphasis based on real-time performance monitoring (Kurniawan et al., 2022). This adaptive approach addresses the heterogeneity of learner needs characteristic of typical classroom environments, enabling accelerated progression for advanced learners while providing additional scaffolding and practice opportunities for students struggling with particular technical elements. Traditional demonstration-based instruction, by contrast, necessitates pace selection that attempts to accommodate the average learner, often resulting in insufficient challenge for advanced students and insufficient support for those requiring additional practice.

The enhanced performance consistency evident in the AI-assisted group, as reflected by lower coefficient of variation and greater reliability across multiple performance trials, suggests that AI-mediated learning cultivates more robust and stable skill acquisition compared to conventional methods. This consistency indicates that learning gains achieved through AI-assisted practice manifest not as inconsistent performance fluctuations but rather as genuinely internalized motor memories exhibiting reliable expression across varied practice contexts. The temporal trajectory analysis revealing deceleration in conventional group improvement during intervention weeks 7-12 provides additional insight into differential mechanisms of learning. This plateauing effect may reflect limitations of conventional instruction in advancing beyond initial skill acquisition toward genuine mastery and technical refinement, whereas AI-guided practice continues providing novel challenges and progressive refinement opportunities.

The dimensional analysis examining specific aspects of technique quality enriches interpretation of overall findings. The particularly pronounced advantage for the AI group on execution speed ($d = 1.16$) and technique accuracy ($d = 1.09$) suggests that AI systems excel particularly at providing feedback on these quantifiable, measurable movement parameters. The more modest effect size for power expression ($d = 0.68$), though still substantial, may reflect a limitation of current AI measurement capabilities in accurately quantifying force generation from video analysis alone. Future technology development incorporating force plates, accelerometers, or other kinetic sensors might enhance AI system capacity to evaluate power-related dimensions of performance.

The absence of significant moderating effects related to participant gender implies that AI-assisted learning approaches provide benefits applicable across demographic groups, suggesting the approach's generalizability beyond specific learner subpopulations. Both male and female participants benefited substantially from the AI-assisted method, supporting recommendations for inclusive implementation of such technologies across diverse student populations. However, the somewhat larger effect size among female participants ($d = 1.08$ versus $d = 0.82$ for males) warrants further investigation to determine whether gender-based differences reflect genuine differential responsiveness to technology-mediated instruction or represent sampling artifacts.

The superior efficacy of AI-assisted learning should not, however, be interpreted as rendering traditional instructor-led methods obsolete or unnecessary. Contemporary educational philosophy increasingly emphasizes the concept of blended learning, wherein technology-enhanced and traditional instructional methods are strategically integrated to leverage the distinctive advantages of each approach (Wijaya & Sutedjo, 2021). The personal mentorship dimensions, motivational support, and socialization opportunities provided by instructor-led instruction possess intrinsic educational value extending beyond technical skill development. Furthermore, the development of meta-cognitive and self-regulatory capacities through interaction with human instructors may produce long-term learning advantages extending beyond the immediate skill acquisition period assessed in this investigation. Optimal pedagogical approaches likely involve integration of AI feedback systems within frameworks that maintain meaningful instructor presence and personalized human guidance.

The research context and generalizability present important considerations for interpretation. This study was conducted within a university elective course environment with undergraduate students entering with zero prior martial arts experience. Whether findings would generalize to youth populations, advanced practitioners, or mandatory curriculum contexts remains uncertain and warrants future investigation (Hadianto et al., 2023). Additionally, the 12-week intervention window, while sufficient to detect meaningful differences in foundational skill acquisition, may not capture longer-term trajectories or retention of learning gains. Longitudinal investigations examining skill persistence months following intervention completion would strengthen understanding of differential learning durability between methods.

Technical and practical limitations merit acknowledgment. The AI platform employed in this study required specific environmental setup including depth-sensing cameras and controlled lighting conditions, potentially limiting accessibility in resource-constrained educational settings. Training required by instructors to effectively integrate AI systems into existing curricula, combined with ongoing technical maintenance responsibilities, represents additional implementation burden compared to conventional instruction requiring minimal technology infrastructure (Rohman et al., 2023). Cost considerations, though not explicitly addressed in this investigation, may substantially constrain AI adoption in many educational contexts, particularly within developing nations or institutions with limited technology budgets.

5 Conclusion

This quasi-experimental classroom study provides substantial empirical evidence that AI-assisted self-learning approaches produce significantly superior outcomes in martial arts technique execution quality compared to conventional instructor-led demonstration methods. The large effect sizes, consistent advantages across multiple performance dimensions, and enhanced performance consistency associated with the AI-assisted group suggest meaningful practical advantages extending beyond statistical significance. However, these findings should be interpreted within the context of a specific educational setting with particular participant characteristics and time-limited intervention window.

Educational institutions and martial arts programs considering technology integration should prioritize implementation of AI-assisted learning platforms as complementary components within existing instructional frameworks rather than replacement approaches. Hybrid models

combining AI-mediated feedback for technical refinement with instructor-led mentorship for motivational and relational development likely represent optimal pedagogical configurations. Instructors should receive comprehensive training in effectively interpreting and communicating AI-generated feedback to students, ensuring that technological input enhances rather than displaces meaningful human guidance. Resource constraints should not be permitted to prevent consideration of AI technology adoption, as demonstration of substantial efficacy justifies prioritization of budget allocation toward technology infrastructure in martial arts and sports education programs.

Future investigations should examine whether observed learning advantages translate to longer-term skill retention and transfer to novel contexts beyond the specific techniques assessed in this study. Longitudinal investigations tracking participants months following intervention completion would clarify sustainability of learning gains and potential differential decay between groups. Research incorporating diverse populations including youth martial artists, advanced practitioners, and participants from various cultural contexts would strengthen evidence regarding generalizability of findings. Investigation of optimal integration models combining AI and instructor-led methods, rather than comparing these approaches as alternatives, would likely produce most useful findings for contemporary educators. Research examining cost-effectiveness and implementation feasibility across varied educational contexts would facilitate evidence-based decision-making regarding technology adoption. Finally, neuroimaging investigations examining differential neural activation patterns during learning under AI-assisted versus conventional conditions would illuminate neurocognitive mechanisms explaining observed behavioral differences.

The convergence of artificial intelligence capabilities with sports pedagogy represents a significant development in educational technology with substantial implications for martial arts training and broader physical education domains. This investigation demonstrates that appropriately designed AI systems can substantially enhance skill acquisition outcomes, providing objective feedback and personalized learning pathways that exceed capabilities of traditional instruction. Simultaneously, preservation of human elements in education remains essential for comprehensive learner development. The path forward likely involves sophisticated integration of technological innovation with enduring educational principles emphasizing mentorship, motivation, and meaningful human connection. As technology continues advancing and educational practices evolve, empirically-grounded investigations such as this contribute essential evidence supporting informed decision-making regarding technology integration in traditional discipline contexts.

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