Physical Education Theory and Methodology
Теорія та методика фізичного виховання

ISSN 1993-7989 (print)
ISSN 1993-7997 (online)
ISSN-L 1993-7989

Original Scientific Articles. Pedagogical Models and Instructional Design

Game-Based Learning Effects on Holistic Outcomes in Pencak Silat Instruction

Nur Rohmah Muktiani[1ABCDE], Saryono[1ABCDE], Muhammad Sigit Antoni[1ABCDE], La Ode Adhi Virama[2ABCDE] and Dewangga Yudhistira[3ABCDE]

[1]Universitas Negeri Yogyakarta
[2]Institut Agama Islam Negeri Kendari
[3]Universitas Negeri Surabaya

Authors' Contribution: A – Study design; B – Data collection; C – Statistical analysis; D – Manuscript Preparation; E – Funds Collection

Corresponding Author: Nur Rohmah Muktiani, e-mail: nur_rohmah@uny.ac.id
Accepted for Publication: July 10, 2026
Published: July 24, 2026

DOI: 10.17309/tmfv.2026.4.07

Abstract

Background. Pencak Silat instruction in Indonesian secondary schools remains predominantly teacher-centered, limiting student engagement across cognitive, affective, and psychomotor domains.

Objectives. To examine the effects of an explicitly progressive Game-Based Learning (GBL) sequence based on modified Teaching Games for Understanding (TGfU) games on holistic learning outcomes in Pencak Silat instruction.

Materials and Methods. A quasi-experimental pre-test–post-test design was employed with 60 ninth-grade students assigned to an experimental group ($n = 30$; eight-week progressive GBL sequence) or a control group ($n = 30$; conventional instruction). Cognitive, affective, and psychomotor outcomes were assessed using instruments validated through expert content validity (Aiken's V), pilot testing of internal consistency, and dual-observer inter-rater reliability. Independent- and paired-samples t-tests and one-way MANOVA were conducted.

Results. The experimental group significantly outperformed the control group on cognitive ($d = 0.579$), affective ($d = 4.580$), and psychomotor ($d = 4.294$) post-test scores (all $p < .05$). MANOVA confirmed a significant simultaneous group effect across all three domains (Wilks' $\Lambda = 0.128$, $F = 131.68$, $p < .001$, $\eta^2 = .872$).

Conclusions. A progressively sequenced GBL intervention produced significantly superior holistic learning outcomes in Pencak Silat compared with conventional instruction. The exceptionally large affective and psychomotor effect sizes should be interpreted cautiously given the restricted-range rating instruments used and are best understood as indicating a clear directional advantage rather than a precise quantification of the true effect magnitude.

Keywords: game-based learning, pencak silat, physical education, cognitive outcomes, affective outcomes, psychomotor outcomes, teaching games for understanding.

Introduction

Physical education is widely recognized as a vital component of the school curriculum, charged with simultaneously fostering cognitive competence, affective development, and psychomotor mastery the three fundamental dimensions articulated in Bloom's Taxonomy (Bloom et al., 1956; Krathwohl, 2002). The integration of all three learning domains within a unified instructional framework is regarded as the hallmark of high-quality physical education, yet persistent challenges remain in designing instructional approaches capable of sustaining meaningful student engagement across all three dimensions concurrently (Bailey, 2006; Beni et al., 2019). In this regard, the quality of instructional approaches has been consistently identified as a critical determinant of student learning trajectories (Kirk & MacPhail, 2002; Rink, 2014).

Among contemporary instructional innovations, Game-Based Learning (GBL) broadly defined as an approach that integrates structured game elements such as rules, goals, feedback, and challenge into learning activities to promote active and purposeful participation (Plass et al., 2015; Van Eck, 2006) has attracted considerable scholarly attention. In physical education, GBL is operationalized through modified games: systematic adaptations of sport and game structures that preserve motivational qualities while aligning with curricular objectives (Hastie & Curtner-Smith, 2006; Butler & McCahan, 2005). Empirical reviews consistently document that GBL interventions in physical education are associated with increased student engagement (Harvey & Jarrett, 2014; Yan et al., 2022), higher intrinsic motivation (Ntoumanis, 2001; Deci & Ryan, 2000), and improved learning outcomes compared with conventional direct instruction (Ezeddine et al., 2025; Ortiz et al., 2023).

In the Indonesian school curriculum, Pencak Silat a traditional martial art rooted in Nusantara cultural heritage occupies a mandatory position in physical education at primary and secondary levels (Ministry of Education and Culture of the Republic of Indonesia, 2016). As an activity integrating technical execution, tactical reasoning, and deeply embedded cultural values such as discipline, sportsmanship, and respect, Pencak Silat offers a uniquely rich pedagogical context in which cognitive, affective, and psychomotor domains converge (Maryono, 1998; Lubis & Wardoyo, 2016). Nevertheless, instruction in Pencak Silat in Indonesian secondary schools has been predominantly characterized by teacher-centered approaches emphasizing repetitive technique drills, with limited attention to pedagogical strategies capable of stimulating higher-order thinking, fostering affective internalization, or enhancing intrinsic motivation (Vertonghen & Theeboom, 2010; Vertonghen et al., 2014).

A critical gap exists in the GBL literature: research has largely focused on team and invasion sports such as football, basketball, and volleyball (Casey & MacPhail, 2018; Harvey & Jarrett, 2014), with very few studies examining GBL in martial arts or traditional sports contexts. More critically, existing GBL studies in physical education rarely adopt a multidomain learning outcomes framework that simultaneously investigates all three domains within a single experimental design (Camacho-Sánchez et al., 2023; Memmert et al., 2015), and fewer still specify the within-program progression by which a sequence of modified games is intended to scaffold increasingly complex cognitive, affective, and psychomotor demands. This represents a significant gap given that the three domains are inherently interdependent in culturally grounded activities such as Pencak Silat (Alafnan, 2025; Wilson, 2006).

This study is theoretically grounded in constructivist learning theory (Vygotsky, 1978) and the Teaching Games for Understanding (TGfU) model (Bunker & Thorpe, 1982). Within this framework, GBL through modified games positions students as active problem-solvers who simultaneously develop tactical understanding (cognitive), emotional engagement (affective), and technical execution (psychomotor) within authentic game contexts. Central to TGfU's instructional logic is the principle of progressive complexity: tasks are sequenced so that each game builds upon the technical and tactical foundation established by the preceding one, allowing the instructional demand on each domain to increase systematically across the program (Bunker & Thorpe, 1982; Kirk & MacPhail, 2002). This integrative, progression-based perspective aligns with recent developments in physical education pedagogy calling for instructional models capable of addressing the full spectrum of student learning outcomes through clearly specified instructional sequencing (Kirk, 2010; Light, 2012).

The present study therefore pursues two objectives: (1) to determine whether a progressively sequenced program of TGfU-based modified games produces significantly better cognitive, affective, and psychomotor learning outcomes in Pencak Silat instruction than conventional approaches; and (2) to provide an explicit, reproducible account of the instructional logic by which each modified game in the sequence was designed to target specific domain demands, thereby contributing experimental evidence and a transferable pedagogical model supporting the integration of TGfU-based GBL into Pencak Silat pedagogy in Indonesian secondary schools. Based on constructivist theory and the extant literature, it is hypothesized that the GBL group will demonstrate significantly superior post-test outcomes than the control group across all three learning domains, individually and simultaneously.

Materials and Methods

Research Design

A quasi-experimental non-equivalent control group pre-test–post-test design was employed (Thomas et al., 2022). Group assignment was based on intact class groupings, as is commonly applied in educational research in school settings where true randomization is logistically constrained (Creswell & Creswell, 2018). Both groups were assessed at identical time points before (pre-test) and after (post-test) the intervention. Baseline equivalence of groups was evaluated statistically prior to hypothesis testing. The study followed CONSORT guidelines for quasi-experimental designs insofar as applicable to non-randomized trials.

Participants

Participants were 60 Grade IX students from SMP Negeri 4 Sewon, Bantul Regency, Special Region of Yogyakarta, Indonesia. The control group (Class IX A, n = 30) received conventional instruction, and the experimental group (Class IX B, n = 30) received GBL. Participants were selected using purposive sampling based on the equivalence of baseline academic achievement and prior Pencak Silat learning experience between the two intact classes. A sample of 30 per group is considered adequate for two-group parametric comparisons with a medium effect size at $\alpha = .05$, power = .80 (Cohen, 1988). Participant characteristics are presented in Table 1.

Table 1. Participant Characteristics by Group

Characteristic	Control (n=30)	Experimental (n=30)
Class	IX A	IX B
Age M (SD), years	14.2 (0.7)	14.1 (0.8)
Boys, n (%)	16 (53.3)	17 (56.7)
Girls, n (%)	14 (46.7)	13 (43.3)
PE experience (years) M (SD)	3.1 (0.6)	3.0 (0.5)
Prior Pencak Silat exposure, n (%)	12 (40.0)	11 (36.7)

Note. PE = physical education.

Intervention: Progressive Sequence of Modified Games

In direct response to the requirement for a fully reproducible pedagogical model, the experimental group's eight-week intervention was structured as an explicit progression of eight distinct modified games, each building cumulatively on the technical and tactical content of the preceding week. The progression followed TGfU's instructional logic of incremental complexity (Bunker & Thorpe, 1982; Kirk & MacPhail, 2002): Weeks 1–2 isolated single technical elements (stance, paired synchrony) under minimal cognitive load; Weeks 3–4 introduced spatial and tactical decision-making layered onto the established technical base; Weeks 5–6 integrated technical and tactical elements within small-sided cooperative game structures, introducing the affective dimension explicitly; and Weeks 7–8 required full integration of all three domains under authentic, scenario-based and student-directed conditions. This design ensures that observed cognitive, affective, and psychomotor gains can be traced to specific, identifiable instructional mechanisms at each stage of the program rather than to an undifferentiated eight-week exposure.

Table 2. Weekly Progression of TGfU-Based Modified Games: Rules, Domain Targets, and Instructional Mechanisms

Week	Modified Game	Rules & Progression Logic	Primary Domain Targeted	Instructional Mechanism
1.	"Stance Tag" (Kuda-Kuda Berkejar)	Students move using basic kuda-kuda (stance) transitions within a marked grid; 'it' must tag others while maintaining correct stance form. Low cognitive load: rules are simple, success criterion is purely technical (correct stance).	Psychomotor (stance accuracy)	Repetition under light game pressure; teacher calls out stance-check freezes
2.	"Mirror Stance" (Cermin Kuda-Kuda)	Paired students mirror each other's stance changes in real time; pairs alternate leader/follower roles. Introduces a second decision variable (timing synchrony) atop Week 1's technical base.	Psychomotor + early Affective (cooperation)	Peer-paced repetition; immediate visual feedback from partner
3.	"Evasion Circle" (Lingkaran Elak)	Students form a circle; one student in the center must evade two 'attackers' using only evasive footwork (elakan) without leaving the circle boundary. Adds spatial decision-making to the existing technical base.	Cognitive (spatial decision-making) + Psychomotor (footwork)	Constrained decision-making under time pressure; teacher prompts 'why did you move that way?'
4.	"Distance Keeper" (Penjaga Jarak)	Paired drill requiring students to maintain optimal striking distance (jarak pukul) while a partner varies approach speed unpredictably. Builds on Week 3's spatial awareness with an added tactical-timing layer.	Cognitive (tactical timing) + Psychomotor (distance control)	Trial-and-error with immediate consequence (contact = error signal); post-task group debrief
5.	"Controlled Strike-Counter" (Serang-Balas Terkendali)	Paired students alternate controlled, low-intensity strike and counter-strike sequences combining stance, evasion, and distance control learned in Weeks 1–4. Full technical integration begins here.	Psychomotor (integration) + Cognitive (sequencing)	Scaffolded complexity increase; teacher circulates with individualized prompts
6.	"Team Defense Line" (Garis Pertahanan Tim)	Small-sided team game (3v3) in which one team must collectively defend a line using stance, evasion, and distance principles against attacking partners. Introduces social/tactical cooperation under Week 5's technical base.	Affective (cooperation, respect for partner safety) + Cognitive (team tactics)	Cooperative small-sided game; teacher facilitates post-game group reflection on tactical choices
7.	"Scenario Sparring" (Sparring Skenario)	Controlled scenario-based paired sparring with assigned roles (e.g., 'defender must use only evasion for first 10 seconds'). Requires full integration of all previously learned tactical-technical elements under realistic time constraints.	All three domains integrated	Authentic game-like constraint application; teacher uses Socratic questioning post-bout
8.	"Values Showcase" (Unjuk Nilai)	Students design and perform a short paired routine integrating technical skill, tactical decision-making, and explicit demonstration of Pencak Silat values (respect, discipline, sportsmanship) for peer and teacher evaluation.	Affective (value internalization) + summative integration of all domains	Student-directed synthesis task with peer and teacher assessment using rubric criteria

Note. Game names presented in English with the original Bahasa Indonesia terminology in parentheses. Each week's game was designed to incorporate and extend the technical-tactical content of the preceding week(s), consistent with TGfU's principle of progressive complexity (Bunker & Thorpe, 1982).

Table 2 presents the complete weekly progression, including the rules, instructional logic, and primary domain target of each modified game.

Table 3 presents the standard five-phase structure applied within every session, into which the week-specific modified game (Table 2) was embedded as the core activity.

Table 3. Standard Session Structure and Instructional Purpose of Each Phase

Phase	Duration	Activity	Instructional Purpose
1	10 min	Warm-up game (low-intensity variant of week's modified game)	Activates relevant motor pattern; primes cognitive focus for the session theme
2	35 min	Core modified game task (see Table 2 for weekly content)	Primary vehicle for domain-targeted skill and tactical development
3	15 min	Tactical reflection discussion (teacher-facilitated, Socratic questioning)	Converts implicit game experience into explicit tactical/cognitive understanding
4	15 min	Technical practice (isolated repetition of session's key technique)	Consolidates motor pattern in a low-pressure, repetition-focused context
5	5 min	Cool-down and individual reflection log	Physiological recovery; reinforces self-monitoring habit

Note. The core modified game task (Phase 2) varied weekly according to the progression specified in Table 2; all other phases maintained a consistent structure across the eight-week program.

All sessions were delivered by the same licensed physical education teacher, who received four hours of standardized training in TGfU principles and the specific rules and progression logic of each modified game prior to the intervention, in order to control for teacher effects and to maximize fidelity of implementation. A second trained observer independently verified adherence to the planned game rules and session structure in 25% of randomly selected sessions (fidelity checklist agreement = 96%). The control group received conventional Pencak Silat instruction of equivalent total duration, comprising teacher demonstration, repetitive technique drilling, and structured practice under teacher direction, without modified games, tactical reflection discussion, or the progressive complexity structure described above.

Instrumentation, Validity, and Reliability

Three domain-specific instruments were administered at both pre-test and post-test. Table 4 summarizes the instrument type, item count, scoring range, and content coverage for each domain.

Content validity of all three instruments was established through review by three independent experts (two Pencak Silat coaching specialists and one physical education measurement specialist), who rated each item's relevance to its intended construct using Aiken's V coefficient (Aiken, 1985), with V ≥ .75 considered acceptable for a three-rater panel. Three items in the initial affective rubric draft (V < .75) were revised based on expert feedback prior to piloting. All three instruments were subsequently piloted with a non-study class of comparable grade level and prior Pencak Silat exposure (n = 28) to assess internal consistency (Cronbach's alpha). Table 5 summarizes the content validity, internal consistency, and inter-rater reliability evidence for each instrument.

Because the affective and psychomotor domains depend on observer judgment, additional procedural safeguards were implemented to strengthen inter-rater reliability beyond the ICC values reported in Table 5. Table 6 details the observer qualification, training, scoring, and discrepancy-resolution procedures applied to both rubrics.

Table 4. Description of Cognitive, Affective, and Psychomotor Instruments

Domain	Instrument Type	Items & Scoring	Content Covered
Cognitive	Written test	30 items; scored 0–100	Technique names and sequences, tactical concepts, rules, philosophical values
Affective	Behavioural observation rubric	12 items; 4-point scale (1 = never, 4 = always); range 12–48	Discipline, cooperation, sportsmanship, self-confidence, responsibility
Psychomotor	Movement skill rubric	20 items; 4-point scale; range 20–80	Accuracy, coordination, and fluency of kuda-kuda (stances), punches, kicks, defensive movements

Note. All instruments were developed specifically for this study and administered identically at pre-test and post-test.

Table 5. Validity and Reliability Evidence by Domain

Domain	Content Validity (Aiken's V)	Internal Consistency (Pilot, n = 28)	Inter-Rater Reliability (ICC)
Cognitive	V = .79–.94 (3 expert raters)	Cronbach's α = .84	N/A (written test)
Affective	V = .76–.91 (3 items revised, initial V < .75)	Cronbach's α = .81	ICC = .88, 95% CI [.81, .93]
Psychomotor	V = .78–.93 (3 expert raters)	Cronbach's α = .86	ICC = .91, 95% CI [.85, .95]

Note. ICC = intraclass correlation coefficient (two-way random-effects, absolute agreement). Acceptable thresholds: Aiken's V ≥ .75 (Aiken, 1985); Cronbach's α ≥ .70 (Streiner et al., 2015); ICC ≥ .75 indicates excellent agreement (Landis & Koch, 1977). The cognitive instrument is a written test and therefore was not subject to inter-rater scoring.

Table 6. Observer Training and Scoring Procedure for Affective and Psychomotor Rubrics

Procedure Step	Description
Observer qualifications	Two independent observers, both certified Pencak Silat instructors with ≥ 5 years' coaching experience
Training	4-hour structured session using video-recorded reference performances and consensus-based criterion calibration, prior to data collection
Scoring protocol	Both observers rated all 60 participants independently at pre-test and post-test; blinded to each other's ratings and to group allocation
Discrepancy resolution	A third independent observer's rating was used as the final score when two raters differed by > 1 scale point; required for 4.2% of affective items and 3.1% of psychomotor items
Final score	Mean of the two primary observers' ratings (or third-observer score where the resolution procedure applied)

Note. Both observers were blinded to group allocation throughout the scoring process to minimize expectancy bias.

Statistical Analysis

All analyses were conducted using IBM SPSS Statistics Version 26 ($\alpha = .05$). Descriptive statistics (mean, SD, minimum, maximum) were computed for all variables. Normality was assessed using the Shapiro–Wilk test (Field, 2024). Levene's test was used to assess homogeneity of variance; Welch's correction was applied where homogeneity was violated. For each domain, within-group improvement was examined using paired samples t-tests, and between-group post-test differences using independent samples t-tests. Effect sizes were calculated using Cohen's d (Cohen, 1988; Lakens, 2013): ≥ 0.20 small, ≥ 0.50 moderate, ≥ 0.80 large. The simultaneous effect of group across all three dependent variables was evaluated using one-way MANOVA (Wilks' Λ), with partial η^2 reported (≥ .01 small, ≥ .06 medium, ≥ .14 large). Given that the affective and psychomotor rubrics employed restricted four-point response scales, effect sizes for these two domains are interpreted with explicit caution in the Discussion, consistent with established guidance on effect size interpretation for restricted-range ordinal instruments (Lakens, 2013; Pallant, 2020).

Results

Descriptive Statistics

Table 7 presents pre-test, post-test, and gain scores for both groups across all three learning domains.

Both groups improved from pre-test to post-test across all three domains. The experimental group recorded higher post-test means than the control group in all three domains: cognitive (78.50 vs. 73.33), affective (47.53 vs. 42.17), and psychomotor (48.80 vs. 44.10).

Assumption Tests

Shapiro–Wilk normality test results are presented in Table 8.

Table 8. Shapiro–Wilk Normality Test Results by Variable, Group, and Stage

Variable	Group	Stage	W	p
Cognitive	Control	Pre-test	0.961	.152
	Control	Post-test	0.943	.066
	Experimental	Pre-test	0.966	.189
	Experimental	Post-test	0.944	.067
Affective	Control	Pre-test	0.808	< .001
	Control	Post-test	0.851	.008
	Experimental	Pre-test	0.839	.011
	Experimental	Post-test	0.720	< .001
Psychomotor	Control	Pre-test	0.702	< .001
	Control	Post-test	0.712	< .001
	Experimental	Pre-test	0.698	< .001
	Experimental	Post-test	0.688	< .001

Note. p > .05 indicates normality. Welch's t-test was applied for the affective domain where Levene's test indicated heterogeneous variance (p = .007); Levene's test indicated homogeneous variance for the cognitive (p = .083) and psychomotor (p = .637) domains.

Cognitive data were normally distributed in both groups at both time points (all p > .05). Affective and psychomotor data did not meet normality in most conditions (p < .05), attributable to low score variability reflecting convergence

Table 7. Descriptive Statistics by Group and Measurement Occasion

Variable	Group	n	Pre-test M (SD)	Post-test M (SD)	Gain M
Cognitive	Control	30	53.17 (8.04)	73.33 (6.74)	20.17
	Experimental	30	51.67 (14.16)	78.50 (10.68)	26.83
Affective	Control	30	19.67 (1.24)	42.17 (1.58)	22.50
	Experimental	30	24.33 (1.37)	47.53 (0.51)	23.20
Psychomotor	Control	30	24.17 (1.93)	44.10 (1.24)	19.93
	Experimental	30	29.10 (1.12)	48.80 (0.92)	19.70

Note. M = mean; SD = standard deviation. Affective and psychomotor scores reflect total rubric scores derived from the mean of two independent observer ratings.

toward upper response categories. Per the Central Limit Theorem, with n = 30 per group, sampling distributions of means approximate normality, justifying parametric inference (Field, 2024; Pallant, 2020). Levene's test confirmed homogeneous variance for cognitive ($p = .083$) and psychomotor ($p = .637$) data; Welch's correction was applied for the affective domain (Levene $p = .007$).

Hypothesis Testing

Table 9 presents paired and independent samples t-test results for all three domains.

Table 9. Paired and Independent Samples t-test Results by Domain

Test	t	df	p	Cohen's d
Cognitive: Paired – Control	-11.96	29	< .001	2.183
Cognitive: Paired – Experimental	-10.60	29	< .001	1.935
Cognitive: Independent (post-test)	2.241	58	.029	0.579
Affective: Paired – Control	-58.77	29	< .001	10.731
Affective: Paired – Experimental	-83.73	29	< .001	15.286
Affective: Independent (post-test)[a]	17.738	–	< .001	4.580
Psychomotor: Paired – Control	-69.36	29	< .001	12.662
Psychomotor: Paired – Experimental	-128.97	29	< .001	23.546
Psychomotor: Independent (post-test)	16.629	58	< .001	4.294

Note. [a]Welch's correction applied. Cohen's d classification: ≥ 0.20 small; ≥ 0.50 moderate; ≥ 0.80 large (Cohen, 1988).

Cognitive domain: paired t-tests confirmed significant within-group improvements in both groups (both $p < .001$). The independent samples t-test indicated a significantly higher post-test cognitive score in the experimental group than in the control group, $t(58) = 2.241$, $p = .029$, $d = 0.579$.

Affective domain: paired t-tests confirmed significant within-group improvements in both groups (both $p < .001$). The Welch-corrected independent samples comparison indicated a significantly higher post-test affective score in the experimental group than in the control group, $t = 17.738$, $p < .001$, $d = 4.580$.

Psychomotor domain: paired t-tests confirmed significant within-group improvements in both groups (both $p < .001$). The independent samples t-test indicated a significantly higher post-test psychomotor score in the experimental group than in the control group, $t(58) = 16.629$, $p < .001$, $d = 4.294$.

MANOVA: Table 10 presents the one-way MANOVA results testing the simultaneous group effect across all three domains.

MANOVA indicated a statistically significant simultaneous group effect across all three learning domains, Wilks' $\Lambda = 0.128$, $F = 131.68$, $p < .001$, $\eta^2 = .872$. Univariate follow-up tests indicated statistically significant group differences for each individual domain: cognitive ($F = 5.02$, $p = .029$, $\eta^2 = .080$), affective ($F = 314.64$, $p < .001$, $\eta^2 = .844$), and psychomotor ($F = 276.52$, $p < .001$, $\eta^2 = .827$).

Table 10. One-Way MANOVA Results for Simultaneous Group Effects

Effect	Wilks' Λ	F	p	η^2 (partial)
Group (GBL vs. Conventional)	0.128	131.68	< .001	.872
Cognitive (univariate)	–	5.02	.029	.080
Affective (univariate)	–	314.64	< .001	.844
Psychomotor (univariate)	–	276.52	< .001	.827

Note. η^2 classification: ≥ .01 small; ≥ .06 medium; ≥ .14 large (Cohen, 1988).

Discussion

This study examined whether a progressively sequenced program of TGfU-based modified games produces superior cognitive, affective, and psychomotor learning outcomes in Pencak Silat instruction relative to conventional instruction, and sought to provide a reproducible account of the pedagogical mechanisms underlying any observed effects. The confirmation of significant between-group differences across all three domains, together with a significant simultaneous MANOVA effect, supports the hypothesis that a well-specified instructional progression rather than mere exposure to game-based activity in general drives multidomain skill development.

The moderate cognitive effect ($d = 0.579$) is consistent with the constructivist learning framework (Vygotsky, 1978) and with TGfU's emphasis on tactical understanding as a foundation for technical mastery (Bunker & Thorpe, 1982; Kirk & MacPhail, 2002). The weekly progression documented in Table 2 offers a specific explanation for this effect: cognitive demand was deliberately layered across the program, beginning with technical-only tasks (Weeks 1–2) and progressively introducing spatial decision-making (Week 3), tactical timing (Week 4), and full scenario-based reasoning (Week 7). This staged increase in cognitive load is theoretically consistent with the "challenge point" framework (Guadagnoli & Lee, 2004), which holds that learning is optimized when task difficulty is incrementally matched to learners' developing competence rather than introduced all at once. The moderate (rather than large) cognitive effect size, relative to the very large affective and psychomotor effects, is itself informative: it suggests that higher-order tactical reasoning required more sustained, cumulative exposure to develop than the more direct behavioral and motor outcomes captured by the affective and psychomotor instruments, a pattern consistent with Mayer's (2019) observation that executive cognitive engagement in game-based learning develops more gradually than procedural or behavioral responses.

The affective and psychomotor effect sizes ($d = 4.580$ and $d = 4.294$, respectively) are exceptionally large by any conventional benchmark (Cohen, 1988; Lakens, 2013) and require explicit, critical interpretation rather than face-value acceptance. Three methodological features of the present design plausibly inflate these estimates beyond their true population magnitude. First, both the affective and psychomotor instruments employed restricted four-point rating scales; when post-test scores in the experimental group cluster near the scale ceiling (as observed, with 346 of 360 total experimental-group affective responses falling in the 'Very Good' category), between-group variance is compressed and standardized effect size statistics such as Cohen's d become mathematically inflated independent of the true underlying difference between groups (Lakens, 2013; Pallant, 2020). Second, the same teacher-affiliated observers who delivered or were aware of group assignment scored the rubrics, introducing a plausible expectancy bias risk despite the blinded, dual-observer protocol implemented to mitigate it. Third, the quasi-experimental design without random allocation to condition may also have contributed to the larger observed standardized differences, as non-randomized designs are more susceptible than randomized designs to confounding by unmeasured pre-existing between-class differences that can inflate apparent treatment effects (Thomas et al., 2022). Taken together, these findings should be interpreted as providing strong evidence of a clear directional advantage favoring the experimental condition in the affective and psychomotor domains, rather than as precise, generalizable quantifications of true effect magnitude. Future replications using randomized allocation, rating instruments with wider response ranges (e.g., 7- or 10-point scales), or continuous performance-based measures are needed before the magnitude—rather than merely the direction—of these effects can be considered established.

With this caveat stated, the directional pattern of affective and psychomotor gains remains theoretically interpretable. The progression documented in Table 2 introduced the affective dimension explicitly only from Week 6 onward ("Team Defense Line"), through cooperative small-sided games requiring peer trust and shared tactical responsibility, and culminated in Week 8's "Values Showcase," which required explicit demonstration and peer evaluation of Pencak Silat values. This staged introduction of affective demand is consistent with Self-Determination Theory (Deci & Ryan, 2000, 2013): the modified games' game-embedded autonomy (tactical choice), competence (calibrated challenge), and relatedness (paired and small-group structures) jointly support intrinsic engagement, and the late-stage cooperative and values-based tasks plausibly account for the marked behavioral shift captured by the rubric. For the psychomotor domain, the variable, progressively complex demands of the modified games across Weeks 1-7 moving from isolated stance repetition to fully integrated scenario sparring are consistent with contextual interference and motor variability principles (Magill & Hall, 1990; Porter & Magill, 2010), which predict that variable practice conditions produce more robust and adaptable motor skill than blocked, repetitive drilling of the kind used in the control condition.

The MANOVA result ($\eta^2 = .872$) indicates that the three domains did not improve independently but covaried as a coherent outcome pattern under the GBL condition. Read alongside the weekly progression in Table 2, this multivariate result is consistent with the proposition that cognitive, affective, and psychomotor development are mutually reinforcing when instructional tasks are deliberately designed to integrate all three demands within a single, progressively sequenced activity (Alafnan, 2025; Wilson, 2006), rather than being independently caused by unrelated programme features. This extends the theoretical work of Light (2012) and Correia et al. (2019) on game-sense and nonlinear pedagogies by providing, for the first time, a fully specified and reproducible week-by-week progression demonstrating their multidomain effectiveness in a traditional martial arts context.

Compared with previous studies on game-based and TGfU-informed approaches, the present findings both corroborate and extend the existing evidence base. Harvey and Jarrett's (2014) review of game-centred approaches since 2006 reported consistent, though typically small-to-moderate, gains in tactical and technical performance across team and invasion sports; the present study's moderate cognitive effect (d = 0.579) falls within this established range, suggesting that GBL's cognitive benefits generalize from invasion-sport contexts to a culturally distinct, individual combat sport such as Pencak Silat. Casey and MacPhail (2018) similarly emphasized that models-based approaches to physical education tend to yield their most consistent advantages in engagement and participation-related (i.e., affective) outcomes rather than in technical performance alone; the markedly larger affective gains observed here are broadly consistent with this pattern, though as discussed above the magnitude reported in the present study substantially exceeds typical benchmarks and should be interpreted with the measurement caveats already noted. Ortiz et al.'s (2023) meta-analysis of TGfU randomized controlled trials reported pooled effects in the small-to-moderate range for game performance outcomes, a benchmark against which the present study's very large psychomotor effect again stands out as atypical, reinforcing the need for the cautious interpretation urged above rather than treating the present magnitude as representative of TGfU's typical effect. Finally, Ezeddine et al. (2025), in one of the most recent systematic treatments of game-based physical education, concluded that GBL's documented benefits for motivation and engagement are more consistently established in the literature than its benefits for measurable skill acquisition; the present study's pattern of comparatively modest cognitive gains alongside very large affective and psychomotor gains is therefore only partially aligned with this prior synthesis, and the divergence itself underscores why replication with more sensitive, less restricted measurement instruments is necessary before the present findings can be considered representative of GBL's effect on Pencak Silat skill acquisition specifically, as opposed to motivation and engagement more broadly.

Several limitations should be acknowledged, in addition to the measurement-related caveats discussed above. The quasi-experimental design with intact class assignment limits the strength of causal inference relative to full randomization, and the absence of random allocation may also have contributed to the magnitude of the standardized between-group differences observed, as quasi-experimental designs are known to be more susceptible to inflated effect size estimates than fully randomized designs (Thomas et al., 2022). The sample was drawn from a single school in one regency of Yogyakarta, which constrains generalizability to other regions, school types, and cultural contexts within Indonesia's diverse educational landscape. The eight-week intervention period does not permit conclusions about long-term skill retention or transfer. Future research should employ true randomization where ethically and logistically feasible, include retention tests at 6- and 12-week follow-up, use affective and psychomotor measurement instruments with wider response ranges or continuous scoring to address the ceiling-effect concern raised above, and extend the sample to diverse school contexts across Indonesia and beyond.

Conclusions

This study provides preliminary evidence that a progressively sequenced program of TGfU-based modified games is associated with significantly greater improvements in cognitive, affective, and psychomotor learning outcomes in Pencak Silat instruction than conventional instruction, individually and in simultaneous combination. The cognitive effect (d = 0.579) can be interpreted with reasonable confidence as a moderate, genuine instructional advantage. The affective and psychomotor effects, while statistically significant and directionally consistent with the cognitive finding, were measured using restricted-range rating instruments within a non-randomized quasi-experimental design, both of which plausibly inflated their numerical magnitude; these results should therefore be read as suggestive evidence of a clear directional benefit rather than as precise, generalizable estimates of true effect size. The findings as a whole should be interpreted within the limitations of the quasi-experimental, single-school design described above, pending replication with randomized allocation and more sensitive instruments.

These findings carry practical implications specific to the scope of this study. Physical education teachers instructing Pencak Silat may consider adopting an explicitly progressive sequence of modified games—of the kind detailed in Table 2 as a candidate reproducible instructional model, rather than treating game-based activity as a generic supplementary technique. The detailed weekly progression provided here is intended to allow other practitioners and researchers to replicate, adapt, or critically test this specific instructional sequence in other settings. Given the single-school, eight-week, non-randomized scope of this study, broader claims regarding curriculum-wide or policy-level adoption are not warranted by the present data and would require replication across more diverse school contexts, randomized designs, longer intervention periods, and psychometrically refined affective and psychomotor instruments before such recommendations could be made with confidence.

Informed Consent

Written informed consent was obtained from the parents or guardians of all participants prior to study enrolment. Participants were informed that their involvement was voluntary and that they could withdraw at any time without academic consequence.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

Ai Transparency Statement

The authors used AI-assisted tools for language editing only and take full responsibility for the content of this manuscript.

Acknowledgments

The authors express sincere gratitude to Universitas Negeri Yogyakarta for supporting this research through its Internal Research Grant programme, to the principal, staff, and physical education teacher of SMP Negeri 4 Sewon for their generous facilitation of data collection, and to all students of Classes IX A and IX B for their enthusiastic participation.

Conflict of Interest

The authors declare no conflicts of interest.

References

Bloom, B.S., Engelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive domain.* Longmans Green.

Krathwohl, D.R. (2002). A revision of Bloom's taxonomy: An overview. T*heory into Practice, 41*(4), 212-218. https://doi.org/10.1207/s15430421tip4104_2

Bailey, R. (2006). Physical education and sport in schools: A review of benefits and outcomes. *Journal of School Health, 76*(8), 397-401. https://doi.org/10.1111/j.1746-1561.2006.00132.x

Beni, S., Ní Chróinín, D., & Fletcher, T. (2019). A focus on the how of meaningful physical education in primary schools. *Sport, Education and Society, 24*(6), 624–637. https://doi.org/10.1080/13573322.2019.1612349

Kirk, D., & MacPhail, A. (2002). Teaching games for understanding and situated learning: Rethinking the Bunker-Thorpe model. *Journal of Teaching in Physical Education, 21*(2), 177-192. https://doi.org/10.1123/jtpe.21.2.177

Rink, J.E. (2014). *Teaching physical education for learning* (7th ed.). McGraw-Hill.

Plass, J.L., Homer, B.D., & Kinzer, C.K. (2015). Foundations of game-based learning. *Educational Psychologist, 50*(4), 258-283. https://doi.org/10.1080/00461520.2015.1122533

Van Eck, R. (2006). Digital game-based learning: It's not just the digital natives who are restless. *EDUCAUSE Review, 41*(2), 16-30.

Hastie, P.A., & Curtner-Smith, M.D. (2006). Influence of a hybrid Sport Education-Teaching Games for Understanding unit on one teacher and his students. *Physical Education and Sport Pedagogy, 11*(1), 1-27. https://doi.org/10.1080/17408980500466813

Butler, J.I., & McCahan, B.J. (2005). *Teaching games for understanding as a curriculum model.* In L.L. Griffin & J.I. Butler (Eds.), Teaching games for understanding: Theory, research and practice (pp. 33-54). Human Kinetics.

Harvey, S., & Jarrett, K. (2014). A review of the game-centred approaches to teaching and coaching literature since 2006. *Physical Education and Sport Pedagogy, 19*(3), 278-300. https://doi.org/10.1080/17408989.2012.754005

Yan, J., Jones, B., Smith, J.J., Morgan, P., & Eather, N. (2022). A systematic review investigating the effects of implementing game-based approaches in school-based physical education among primary school children.

Journal of Teaching in Physical Education, 42(3), 573-586. https://doi.org/10.1123/jtpe.2021-0261

Ntoumanis, N. (2001). A self-determination approach to the understanding of motivation in physical education. *British Journal of Educational Psychology, 71*(2), 225-242. https://doi.org/10.1348/000709901158497

Deci, E.L., & Ryan, R.M. (2000). The 'what' and 'why' of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227-268. https://doi.org/10.1207/S15327965PLI1104_01

Ezeddine, G., Souissi, N., Abaidia, R., Masmoudi, L., Trabelsi, K., & Ammar, A. (2025). Game-based physical education: A pathway to increased student motivation and greater learning outcomes. *Frontiers in Education,* 9, 1531651. https://doi.org/10.3389/feduc.2025.1531651

Ortiz, M., Meroño, L., Morales-Belando, M.T., Vaquero-Cristóbal, R., & González-Gálvez, N. (2023). Teaching games for understanding in game performance and psychosocial variables: Systematic review and meta-analysis of randomized control trials. *Children, 10*(3), 573. https://doi.org/10.3390/children10030573

Ministry of Education and Culture of the Republic of Indonesia. (2016). *Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 21 Tahun 2016 tentang Standar Isi Satuan Pendidikan Dasar dan Menengah.* Government of Indonesia. Official regulation.

Maryono, O. (1998). *Pencak Silat: Merentang waktu.* Pustaka Pelajar.

Lubis, J., & Wardoyo, H. (2016). *Pencak Silat* (3rd ed.). PT Kharisma Putra Utama Offset.

Vertonghen, J., & Theeboom, M. (2010). The social-psychological outcomes of martial arts practice among youth: A review. *Journal of Sports Science and Medicine, 9*(4), 528-537.

Vertonghen, J., Theeboom, M., & Pieter, W. (2014). Mediating factors in martial arts and combat sports: An analysis of type of martial art, characteristics, and social background of young participants. *Perceptual and Motor Skills, 118*(1), 41-61. https://doi.org/10.2466/06.30.PMS.118k14w

Casey, A., & MacPhail, A. (2018). Adopting a models-based approach to teaching physical education. *Physical Education and Sport Pedagogy, 23*(3), 294-310. https://doi.org/10.1080/17408989.2018.1429588

Camacho-Sánchez, R., Manzano-León, A., Rodríguez-Ferrer, J.M., Serna, J., & Lavega-Burgués, P. (2023). Game-based learning and gamification in physical education: A systematic review. *Education Sciences, 13*(2), 183. https://doi.org/10.3390/educsci13020183

Memmert, D., Almond, L., Bunker, D., Butler, J., Fasold, F., Griffin, L., & Hüttermann, S. (2015). Top 10 research questions related to teaching games for understanding. *Research Quarterly for Exercise and Sport, 86*(4), 347-359. https://doi.org/10.1080/02701367.2015.1087294

Alafnan, M.A. (2025). Enhancing educational outcomes using AlAfnan taxonomy: Integrating cognitive, affective, and psychomotor domains. *International Journal of Evaluation and Research in Education, 14*(3), 2419-2437. https://doi.org/10.11591/ijere.v14i3.33147

Wilson, L.O. (2006). *The three domains of learning: Cognitive, affective, and psychomotor/kinesthetic.* ERIC. https://eric.ed.gov/?id=ED552462

Vygotsky, L.S. (1978). *Mind in society: Development of higher psychological processes.* Harvard University Press.

Bunker, D., & Thorpe, R. (1982). A model for the teaching of games in secondary schools. *Bulletin of Physical Education, 18*(1), 5-8.

Kirk, D. (2010). *Physical education futures.* Routledge.

Light, R. (2012). *Game sense: Pedagogy for performance, participation and enjoyment.* Routledge.

Thomas, J.R., Nelson, J.K., & Silverman, S.J. (2022). *Research methods in physical activity* (8th ed.). Human Kinetics.

Creswell, J.W., & Creswell, J.D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). Sage.

Aiken, L.R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement, 45*(1), 131-142. https://doi.org/10.1177/0013164485451012

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum. https://doi.org/10.4324/9780203771587

Streiner, D.L., Norman, G.R., & Cairney, J. (2015). *Health measurement scales: A practical guide to their development and use* (5th ed.). Oxford University Press.

Landis, J.R., & Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics, 33*(1), 159-174. https://doi.org/10.2307/2529310

Field, A. (2024). *Discovering statistics using IBM SPSS statistics* (6th ed.). Sage.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: A practical primer for t-tests and ANOVAs. *Frontiers in Psychology,* 4, 863. https://doi.org/10.3389/fpsyg.2013.00863

Pallant, J. (2020). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS* (7th ed.). Routledge.

Guadagnoli, M.A., & Lee, T.D. (2004). Challenge point: A framework for conceptualizing the effects of various practice conditions in motor learning. *Journal of Motor Behavior, 36*(2), 212-224. https://doi.org/10.3200/JMBR.36.2.212-224

Mayer, R.E. (2019). Computer games in education. *Annual Review of Psychology,* 70, 531-549. https://doi.org/10.1146/annurev-psych-010418-102744

Deci, E. L., & Ryan, R. M. (2013). *Intrinsic motivation and self-determination in human behavior.* Springer.

Magill, R.A., & Hall, K.G. (1990). A review of the contextual interference effect in motor skill acquisition. *Human Movement Science, 9*(3), 241-289. https://doi.org/10.1016/0167-9457(90)90005-X

Porter, J.M., & Magill, R.A. (2010). Systematically increasing contextual interference is beneficial for learning sport skills. *Journal of Sports Sciences, 28*(12), 1277-1285. https://doi.org/10.1080/02640414.2010.502946

Correia, V., Carvalho, J., Araújo, D., Pereira, E., & Davids, K. (2019). Principles of nonlinear pedagogy in sport practice. *Physical Education and Sport Pedagogy, 24*(2), 117-132. https://doi.org/10.1080/17408989.2018.1552673

Вплив навчання на основі ігрового підходу на цілісні результати навчання пенчак силату

Нур Рохмах Муктіані[1ABCDE], Сарьоно[1ABCDE], Мухаммад Сігіт Антоні[1ABCDE], Ла Оде Адхі Вірама[2ABCDE], Девангга Юдхістіра[3ABCDE]

[1]Державний університет Джок'якарти
[2]Державний ісламський інститут Кендарі
[3]Державний університет Сурабаї

Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 10 с., 10 табл., 45 джерел.

Передумови. Викладання пенчак силату в закладах середньої освіти Індонезії залишається переважно орієнтованим на вчителя, що обмежує залученість учнів у когнітивній, афективній та психомоторній сферах.

Мета. Дослідити вплив чітко структурованої прогресивної послідовності навчання на основі ігрового підходу (Game-Based Learning, GBL), побудованої на модифікованих іграх концепції Teaching Games for Understanding (TGfU), на цілісні результати навчання пенчак силату.

Матеріали і методи. Використано квазіекспериментальний дизайн із попереднім і підсумковим тестуванням. У дослідженні взяли участь 60 учнів дев'ятого класу, яких розподілили на експериментальну групу (n = 30; восьмитижнева прогресивна програма GBL) та контрольну групу (n = 30; традиційне навчання). Когнітивні, афективні та психомоторні результати оцінювали за допомогою інструментів, валідованих шляхом експертної оцінки змістової валідності (коефіцієнт V Айкена), пілотного тестування внутрішньої узгодженості та визначення міжекспертної надійності за участю двох спостерігачів. Для аналізу даних застосовано t-тести для незалежних і парних вибірок та одновимірний багатовимірний дисперсійний аналіз (MANOVA).

Результати. Експериментальна група продемонструвала статистично значуще кращі результати порівняно з контрольною за когнітивними ($d = 0{,}579$), афективними ($d = 4{,}580$) та психомоторними ($d = 4{,}294$) показниками підсумкового тестування (усі $p < 0{,}05$). Результати MANOVA підтвердили статистично значущий одночасний вплив групового чинника на всі три сфери (Wilks' $\Lambda = 0{,}128$, $F = 131{,}68$, $p < 0{,}001$, $\eta^2 = 0{,}872$).

Висновки. Прогресивно структуроване втручання на основі GBL забезпечило статистично значуще кращі цілісні результати навчання пенчак силату порівняно з традиційним навчанням. Водночас надзвичайно великі величини ефекту для афективної та психомоторної сфер слід інтерпретувати з обережністю з огляду на використання рейтингових інструментів з обмеженим діапазоном оцінювання; вони радше свідчать про чітку перевагу запропонованого підходу, ніж про точну кількісну оцінку істинної величини ефекту.

Ключові слова: навчання на основі ігрового підходу, пенчак силат, фізичне виховання, когнітивні результати, афективні результати, психомоторні результати, навчання через ігри для розуміння.

Information about the Authors:

Nur Rohmah Muktiani: nur_rohmah@uny.ac.id; https://orcid.org/0009-0005-6465-688X; Department of Sport Education, Faculty of Sport and Health Science, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Depok, Sleman, Yogyakarta 55281, Indonesia.

Saryono: saryono@uny.ac.id; https://orcid.org/0009-0006-9812-2349; Department of Sport Education, Faculty of Sport and Health Science, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Depok, Sleman, Yogyakarta 55281, Indonesia.

Antoni, Muhammad Sigit: sigitantoni@uny.ac.id; https://orcid.org/0000-0002-0944-6987; Department of Sport Education, Faculty of Sport and Health Science, Universitas Negeri Yogyakarta, Jl. Colombo No. 1, Depok, Sleman, Yogyakarta 55281, Indonesia.

Virama, La Ode Adhi: laodeadhivirama@iainkendari.ac.id; https://orcid.org/0000-0002-5081-1026; Faculty of Tarbiyah and Teacher Training, Institut Agama Islam Negeri Kendari, Jl. Sultan Qaimuddin No. 17, Kendari, Southeast Sulawesi 93116, Indonesia.

Yudhistira, Dewangga: dewanggayudhistira@unesa.ac.id; https://orcid.org/0000-0002-4194-1283; Department of Sport Coaching Education, Faculty of Sport and Health Science, Universitas Negeri Surabaya, Jl. Lidah Wetan, Surabaya, East Java 60213, Indonesia.

Cite this article as: Nur Rohmah Muktiani, Saryono, Antoni, M. S., Virama, L. O. A., & Yudhistira, D. (2026). Game-Based Learning Effects on Holistic Outcomes in Pencak Silat Instruction. *Physical Education Theory and Methodology, 26*(4), 724-733. https://doi.org/10.17309/tmfv.2026.4.07

Received: 28.06.2026. Accepted: 10.07.2026. Published: 24.07.2026