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Applying a Deep Learning Instructional Approach in Rhythmic Gymnastics Learning for Phase D Grade VIII Junior High School Students

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ABSTRACT

Purpose of the study: This study aims to examine the effectiveness of a deep learning instructional approach in rhythmic gymnastics learning among Phase D, Grade VIII junior high school students at SMP Negeri 13 Medan, Indonesia. Specifically, the study evaluates the impact of this approach on conceptual understanding, psychomotor skill development, and affective engagement.

Materials and methods: A mixed-methods design combining a quasi-experimental pre-test/post-test approach with qualitative observation was employed. Sixty Grade VIII students (mean age 13.6 ± 0.52 years; 35 female, 25 male) participated across three structured learning sessions. Quantitative instruments included standardized cognitive assessment rubrics, a psychomotor skill rating scale, and a motivation inventory. Qualitative data were gathered through systematic classroom observation, video documentation, and reflective field notes, and analyzed via thematic coding.

Results: Significant improvements were observed across all domains. Conceptual understanding scores increased from 58.3 ± 9.12 to 79.6 ± 7.45 ($p < 0.001$; improvement: 36.5%). Psychomotor scores rose from 61.4 ± 8.76 to 80.8 ± 6.92 ($p < 0.001$; improvement: 31.6%), with notable gains in rhythm accuracy, body coordination, and flexibility. Affective engagement scores improved by 33.6% ($p < 0.001$). Thematic analysis identified five principal themes: enhanced conceptual understanding, psychomotor skill development, motivation and engagement, collaborative learning, and critical thinking in movement.

Conclusions: A deep learning instructional approach provides a meaningful, effective, and holistic framework for rhythmic gymnastics instruction at the junior high school level, yielding significant improvements in cognitive, psychomotor, and affective domains. These findings support the broader adoption of deep learning pedagogies in Physical Education curricula and inform teacher professional development.

Keywords

deep learning pedagogy; rhythmic gymnastics; motor skill development; conceptual understanding; physical education; junior high school.

INTRODUCTION

Contextual Framework

Physical Education (PE) at the junior high school level constitutes an essential component of holistic student development, targeting cognitive, affective, and psychomotor domains in an integrated manner. Within the Indonesian national curriculum framework (Kurikulum Merdeka) (Zarya et al., 2023), Phase D designates the learning trajectory for students in Grades VII through IX (approximately 13–15 years of age), a stage characterized by heightened social awareness, rapid physical growth, and emerging capacity for higher-order thinking (Tanujaya et al., 2021). Rhythmic gymnastics, as a structured movement discipline integrating music, rhythm, and coordinated physical action, represents a canonical content area within this phase. However, prevalent instructional approaches continue to rely on teacher-centered demonstration and rote repetition, thereby failing to capitalize on learners' emerging metacognitive capacities (Sudjana, 2017; Theroux et al., 2025).

The persistent gap between instructional intent and student learning outcomes in rhythmic gymnastics reflects a broader pedagogical challenge confronting PE worldwide: how to transform movement-based content from mechanical mimicry into conceptually grounded, personally meaningful activity (H. et al., 2025). This challenge has been addressed in international scholarship through models such as Teaching Games for Understanding (TGfU), Sport Education, and, more recently, constructivist and deep learning frameworks (Ardha et al., 2025; Harvey et al., 2020; Usher et al., 2015). In the Indonesian context, the systematic application of deep learning principles to movement-based subjects remains empirically underdeveloped, motivating the present investigation.

Critical Examination of Existing Literature

The concept of deep learning as a pedagogical approach originates from cognitive science and educational psychology, describing learning processes that emphasize meaning-making, conceptual integration, and transfer, as opposed to surface approaches characterized by memorization and reproduction (Johnson et al., 2017; Marton & Säljö, 1976; Winje & Løndal, 2020).

In PE contexts, deep learning has been operationalized through analytical observation, video-mediated reflection, peer discussion, and progressive movement construction (Jarvis, 2009). Research across diverse movement disciplines—including dance, swimming, and team sports—has documented that deep learning pedagogies enhance both cognitive understanding and psychomotor proficiency (Lestari & Nugroho, 2021; Sari & Widodo, 2022).

In the domain of rhythmic gymnastics specifically, Mödinger et al. (2021) demonstrated that video-assisted feedback significantly improved movement accuracy and rhythm adherence among adolescent learners. Similarly, Donti et al. (2016) found that structured reflective practice enhanced coordination and self-regulatory capacity in young gymnasts. Within the Indonesian PE literature, Hidayat & Ramli (2020) reported that analytical and reflective learning strategies improved motor comprehension among secondary school students, while (Jurat et al., 2024) documented positive effects of collaborative movement analysis on coordination and self-confidence in rhythmic activities.

Affective dimensions of PE engagement have received increasing scholarly attention. Paraskevaidis & Fokides, (2020) established that exploration-based learning significantly increased student motivation and participatory behavior in PE lessons. Recent systematic reviews have further confirmed that instructional approaches promoting student autonomy and collaborative inquiry are associated with higher intrinsic motivation and sustained physical activity engagement (Ntoumanis et al., 2020; Vasconcellos et al., 2019). Despite these converging findings, controlled investigations specifically examining the effect of a structured deep learning approach on all three learning domains simultaneously within rhythmic gymnastics remain scarce.

Identification of Research Gaps

Prior research has typically addressed individual dimensions of learning in isolation—either psychomotor outcomes or affective engagement—without systematically examining the concurrent and interrelated effects on cognitive understanding. Furthermore, most existing studies have been conducted in higher-income, Western educational settings, leaving a significant evidence gap regarding implementation in Indonesian secondary schools, where curricular reform has introduced Phase D learning competencies that explicitly demand higher-order thinking outcomes in PE. The absence of mixed-methods studies that triangulate quantitative performance data with qualitative process documentation represents a further methodological gap that this study seeks to address.

Rationale for the Research

Preliminary observations at SMP Negeri 13 Medan revealed that students encountered persistent difficulties in synchronizing movement with rhythmic stimuli and demonstrated limited metacognitive awareness of movement principles. Teacher-directed, demonstration-based pedagogy was identified as the dominant instructional mode. Given the Phase D curricular mandate for active, meaning-oriented learning, and the documented efficacy of deep learning frameworks in analogous contexts, a rigorous investigation of deep learning-based instruction in rhythmic gymnastics is both timely and theoretically justified.

Objectives

The specific objectives of this study were: (1) to examine the effect of a deep learning instructional approach on the conceptual understanding of rhythmic gymnastics principles among Grade VIII students; (2) to assess changes in psychomotor performance, including rhythm accuracy, body coordination, and flexibility; (3) to evaluate the influence of this approach on student motivation and affective engagement; and (4) to identify key thematic patterns emerging from qualitative observation of the learning process.

MATERIALS AND METHODS

Study Participants

A purposive sample of 60 Grade VIII students (Phase D) enrolled at SMP Negeri 13 Medan, North Sumatra, Indonesia was recruited for this study during the second semester of the 2024–2025 academic year. Inclusion criteria were: active enrollment in Grade VIII, no documented musculoskeletal injury contraindicating physical activity, and provision of informed consent by both the student and a parent or legal guardian. Students with chronic conditions requiring exercise restriction were excluded ($n = 3$ excluded; $n = 60$ analyzed). The sample comprised 35 female (58.3%) and 25 male (41.7%) participants, with a mean age of 13.6 ± 0.52 years. Detailed demographic characteristics are presented in Table 1.

Table 1. Demographic Characteristics of Study Participants ($n = 60$)

Characteristic	n	%	Mean \pm SD	Range
Age (years)	60	100.0	13.6 \pm 0.52	13–15
Sex – Female	35	58.3	—	—
Sex – Male	25	41.7	—	—
Body Height (cm)	60	100.0	155.4 \pm 6.83	140–172
Body Weight (kg)	60	100.0	48.7 \pm 8.14	36–71
BMI (kg/m^2)	60	100.0	20.1 \pm 3.02	16.2–27.4
Prior gymnastics exp. (Yes)	18	30.0	—	—

SD = standard deviation; BMI = body mass index; exp. = experience.

Study Organization

The instructional intervention was implemented over three consecutive 80-minute PE sessions conducted within a single school week. Each session followed a structured deep learning sequence comprising: (1) Conceptual Activation (10 minutes) — teacher-facilitated discussion of rhythmic principles, movement anatomy, and session objectives; (2) Analytical Observation (15 minutes) — viewing and critically analyzing curated video exemplars of rhythmic gymnastics sequences, with guided questioning; (3) Collaborative Movement Exploration (25 minutes) — small-group (4–5 students) construction of novel movement sequences aligned with instructor-specified rhythmic parameters; (4) Guided Practice and Peer Feedback (20 minutes) — performance of

constructed sequences with structured peer observation and feedback using a standardized rubric; and (5) Reflective Synthesis (10 minutes) — individual and group reflection on movement quality, error identification, and learning progression.

All sessions were conducted by the same certified PE teacher with ten years of experience, who received a two-hour orientation workshop on deep learning implementation prior to the intervention. Sessions were video-recorded in their entirety to support qualitative analysis and inter-rater reliability checks.

Test and Measurements

Cognitive Assessment: A 20-item criterion-referenced test assessed conceptual understanding of rhythmic gymnastics principles, encompassing knowledge of rhythm and tempo, movement mechanics, body alignment, and error identification. Items were validated by three expert Physical Education lecturers (content validity ratio = 0.87) and piloted for reliability (Kuder–Richardson 20 = 0.81).

Psychomotor Assessment: Motor skill performance was evaluated using a validated observational rating scale adapted from the International Gymnastics Federation (FIG) judging criteria for educational gymnastics. Subscales assessed rhythm accuracy (synchronization of movement with musical beat), body coordination (upper–lower limb integration), and flexibility (sit-and-reach modified protocol, cm). Each subscale was scored 0–100 by two independent raters; inter-rater reliability was confirmed (ICC = 0.91; 95% CI: 0.86–0.94).

Affective Assessment: Student motivation was measured using the Physical Education Motivation Scale (PEMS), a 16-item, 5-point Likert-type instrument validated for Indonesian secondary school students (Cronbach alpha = 0.88; Hidayat & Ramli, 2020). Student engagement was additionally quantified via a structured observation checklist completed by two independent observers at five-minute intervals throughout each session.

Qualitative Data Collection: Systematic observation field notes, video footage transcriptions, and student reflective journals were collected throughout the intervention. Thematic analysis followed the six-phase framework of Braun and Clarke (2006): data familiarization, initial code generation, theme search, theme review, theme definition and naming, and report writing.

Statistical Analysis

Quantitative data were analyzed using IBM SPSS Statistics version 27.0. Normality was assessed with the Shapiro–Wilk test. Paired-samples t-tests were used to compare pre- and post-intervention scores for normally distributed outcomes; the Wilcoxon signed-rank test was applied where normality assumptions were violated. Effect sizes were computed as Cohen's d for t-test comparisons, with d = 0.2, 0.5, and 0.8 interpreted as small, medium, and large effects, respectively (Lachenbruch & Cohen, 1989). The significance threshold was set at alpha = 0.05 for all tests. Descriptive statistics are reported as means ± standard deviations. Thematic analysis data were managed and coded using MAXQDA 2022 software.

Ethical Considerations

The study was conducted in accordance with the Declaration of Helsinki (“World Medical Association Declaration of Helsinki,” 2013) and received ethical clearance from the Research Ethics Committee of Universitas Negeri Medan (Ref. No. 145/UN33.9/EC/2024). Institutional and headmaster approval was obtained from SMP Negeri 13 Medan prior to data collection. Written informed assent and parental/guardian consent were obtained from all participants. Participation was voluntary, and students were informed of their right to withdraw at any time without penalty. All data were anonymized prior to analysis, and video recordings were used exclusively for research purposes under strict confidentiality protocols.

RESULTS

Quantitative Outcomes Across Learning Domains

Pre- and post-intervention comparisons across all assessed domains revealed statistically significant improvements following the deep learning instructional intervention. Results are summarized in Table 2.

Table 2. Pre- and Post-Intervention Scores Across Learning Domains (n = 60)

Learning Outcome Domain	Pre-test Mean ± SD	Post-test Mean ± SD	Improvement (%)	p-value*
<i>Cognitive (Conceptual Understanding)</i>	58.3 ± 9.12	79.6 ± 7.45	36.5	< 0.001
<i>Psychomotor (Motor Skill Score)</i>	61.4 ± 8.76	80.8 ± 6.92	31.6	< 0.001
<i>Rhythm Accuracy (% correct)</i>	52.7 ± 10.3	77.5 ± 8.61	47.1	< 0.001
<i>Body Coordination Score</i>	59.8 ± 9.55	81.2 ± 7.18	35.8	< 0.001
<i>Flexibility Assessment (cm)</i>	22.4 ± 4.67	28.9 ± 4.12	29.0	< 0.001
<i>Affective (Motivation Scale)</i>	63.1 ± 8.44	84.3 ± 6.78	33.6	< 0.001
<i>Student Engagement Index</i>	60.9 ± 9.21	83.7 ± 7.34	37.4	< 0.001

* Paired-samples t-test (p < 0.001 for all comparisons); SD = standard deviation; all post-intervention improvements significant at p < 0.001.

The largest absolute improvement was recorded in rhythm accuracy (pre: 52.7 ± 10.3; post: 77.5 ± 8.61; improvement: 47.1%; p < 0.001), reflecting the particular responsiveness of this domain to analytical and reflective instruction. Flexibility, as measured by the modified sit-and-reach test, improved by 29.0% (pre: 22.4 ± 4.67 cm; post: 28.9 ± 4.12 cm; p < 0.001). Cohen's d values for all paired comparisons exceeded 1.2, indicating large effect sizes across all learning domains.

Thematic Analysis: Qualitative Findings

Thematic analysis of observational field notes, video transcriptions, and student reflective journals yielded five principal themes, as presented in Table 3. Representative evidence and theme frequency are documented for each category.

Table 3. Thematic Analysis Outcomes from Qualitative Data (n = 60)

Thematic Category	Sub-themes Identified	Supporting Evidence	Frequency
<i>Enhanced Conceptual Understanding</i>	Rhythm–movement linkage; Tempo awareness	Observation notes; Verbal explanations	High
<i>Psychomotor Skill Development</i>	Coordination; Flexibility; Balance	Performance rubric; Video analysis	High
<i>Motivation & Engagement</i>	Active participation; Confidence building	Field notes; Self-reflection logs	Moderate–

Collaborative Learning	Peer feedback; Group choreography	Observation; Group presentations	High
Critical Thinking in Movement	Error self-correction; Movement analysis	Student reflections; Field notes	Moderate
Frequency classification: High = emergent in > 70% of observation units; Moderate = 40–70%; Low = < 40%.			Moderate

Theme 1 — Enhanced Conceptual Understanding: From Session 1 onward, students demonstrated a discernible progression in their capacity to articulate relationships between musical tempo and movement speed. By Session 3, the majority of students could independently describe the biomechanical rationale for synchronizing arm and leg movements with rhythmic cues, a capacity absent in baseline observations.

Theme 2 — Psychomotor Skill Development: Video documentation corroborated rubric-based scores, revealing progressive refinement of coordination quality, postural stability, and rhythmic precision across sessions. Students who received structured peer feedback demonstrated accelerated improvement compared to self-directed practice alone.

Theme 3 — Motivation and Engagement: Field notes recorded a marked increase in voluntary participation, on-task behavior, and student-initiated questioning across sessions. Students who had been disengaged in initial observations became progressively more participatory, particularly during peer-feedback and choreography construction phases.

Theme 4 — Collaborative Learning: Group choreography tasks generated substantive peer dialogue regarding movement selection, rhythmic alignment, and sequence logic. These interactions promoted both content learning and interpersonal communication skills.

Theme 5 — Critical Thinking in Movement: Student reflective journals evidenced growing capacity for movement error identification and corrective reasoning. By Session 3, most students demonstrated ability to analyze peers' and their own movement errors independently and propose corrective strategies — a higher-order skill not elicited by conventional instruction.

DISCUSSION

Interpretation of Research Outcomes

The present investigation demonstrates that a structured deep learning instructional approach produces robust and statistically significant improvements across cognitive, psychomotor, and affective learning domains in Grade VIII rhythmic gymnastics instruction. The magnitude of observed effects — with Cohen's *d* consistently exceeding 1.2 — indicates that the intervention exerted a large practical impact, substantially exceeding what would be anticipated from conventional demonstration-based PE instruction. These findings align with the theoretical predictions of deep learning pedagogical frameworks, which posit that instruction emphasizing analytical engagement, reflective synthesis, and collaborative knowledge construction produces qualitatively superior and more durable learning outcomes than surface-level approaches (Bauer et al., 2025; Fitrah et al., 2025; Nugent et al., 2023).

The particularly pronounced gains in rhythm accuracy (47.1%) are theoretically attributable to the analytical observation and peer-feedback components of the intervention, which provided students with multiple opportunities to develop perceptual discrimination between rhythm-conforming and rhythm-deviant movement patterns. This perceptual-analytical mechanism has been identified as a critical driver of skilled motor acquisition in rhythm-dependent activities (Bella et al., 2024; Tichko et al., 2022; Vazou et al., 2020), reinforcing the ecological validity of the deep learning protocol employed here.

Evaluation in Relation to Antecedent Studies

The cognitive improvements documented in this study — specifically, the development of students' capacity to analyze movement errors and articulate rhythmic principles — are consistent with the findings of Orangi et al. (2025), who reported enhanced motor comprehension among Indonesian secondary students exposed to analytical learning strategies. The present results extend those findings by demonstrating that improvements in conceptual understanding co-occur with, and may potentiate, simultaneous psychomotor gains — a concurrent relationship that prior studies examined only partially.

Affective outcomes in the present study align with the broad literature on autonomy-supportive PE instruction. Costa & Reis (2025) and Romar et al. (2016), in systematic reviews, established that instructional environments providing student choice, collaborative inquiry, and reflective engagement are reliably associated with higher intrinsic motivation and deeper commitment to learning tasks. The motivation improvements observed here (33.6%) corroborate these meta-analytic estimates and confirm their replicability in an Indonesian school context.

The five themes emerging from qualitative analysis parallel the thematic structures reported by Fitrah et al. (2025) and Prihantoro et al. (2025) in analogous deep learning PE interventions at the secondary level in Indonesia, suggesting cross-site consistency in the phenomenology of deep learning implementation. The emergence of critical thinking in movement as a prominent theme is particularly notable, as this outcome is rarely assessed or documented in standard PE research, yet represents a core competency target of the Phase D Indonesian curriculum.

Implications of the Discoveries

These findings carry significant implications for PE curriculum design, pedagogical practice, and teacher professional development. The demonstrated efficacy of a three-session deep learning protocol suggests that even brief, well-structured interventions can produce measurable change across all learning domains, offering a feasible model for implementation within standard school timetabling constraints. The integration of video analysis, structured peer feedback, and guided reflection — without requiring specialist facilities or technology beyond a standard screen — indicates that the approach is scalable across diverse resource contexts characteristic of Indonesian public secondary schools.

At the policy level, the alignment of deep learning outcomes with Phase D competency targets provides empirical justification for integrating deep learning methodologies into national PE teacher education curricula and in-service professional development programs. The collaborative and reflective elements of the protocol additionally address broader educational priorities,

including the development of communication, critical thinking, and cooperation — competencies explicitly foregrounded in Indonesia's national education reform agenda.

Recognizing the Constraints of the Research

Several limitations of the present study must be acknowledged. First, the absence of a concurrent control group receiving conventional instruction limits the capacity to attribute observed improvements exclusively to the deep learning intervention, as maturational effects, regression to the mean, and test-retest familiarity may partially account for pre–post gains. Future research should employ randomized controlled designs with matched control groups. Second, the three-session intervention period, while pragmatically constrained by school scheduling, does not permit assessment of long-term knowledge retention or skill transfer; longitudinal follow-up investigations are warranted. Third, while the sample size is adequate for the planned statistical analyses, it was drawn from a single school, which restricts the generalizability of findings to other institutional and regional contexts. Multi-site replication studies would strengthen external validity. Fourth, social desirability effects may have influenced self-reported motivation scores, despite steps taken to ensure anonymous completion of the motivation inventory.

CONCLUSION

This study provides rigorous empirical evidence that a structured deep learning instructional approach significantly enhances conceptual understanding, psychomotor skill proficiency, and affective engagement among Grade VIII junior high school students undertaking rhythmic gymnastics as part of the Phase D Physical Education curriculum. Improvements of substantial magnitude — ranging from 29.0% (flexibility) to 47.1% (rhythm accuracy) — were recorded across all quantitatively assessed dimensions, while qualitative thematic analysis revealed coherent patterns of enhanced critical thinking, collaborative learning, and metacognitive development.

These findings reinforce theoretical frameworks linking analytic, reflective, and collaborative instructional design to deeper and more durable learning outcomes, and extend their empirical base into the underexplored domain of movement-based education in Indonesian secondary schools. The demonstrated feasibility of the protocol within standard curricular time allocations and with widely available resources strengthens its translational value for practitioners.

The authors recommend that Physical Education curriculum designers and school administrators consider the systematic integration of deep learning pedagogical elements — specifically, structured analytical observation, guided peer feedback, collaborative movement construction, and facilitated reflection — into rhythmic gymnastics and analogous movement curriculum units. Teacher professional development programs should incorporate training in deep learning facilitation as a core competency. Future research should pursue randomized controlled designs, longitudinal assessment, multi-site replication, and investigation of individual difference moderators, including sex, prior movement experience, and teacher pedagogical competence, to further delineate.

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CONFLICT OF INTERESTS

The authors declare no conflict of interest with respect to the research, authorship, and publication of this article. No financial or personal relationships with organizations or individuals could inappropriately influence (bias) this work.

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