SPORT TK-EuroAmerican Journal of Sport Sciences

https://revistas.um.es/sportk Online ISSN: 2340-8812

Received: **11/05/2025.** Accepted: **14/09/2025.** Published: **30/12/2025**

Enhancing critical thinking skills through rhythmic gymnastics activities

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ABSTRACT

This study explored the potential of gross motor activities—particularly rhythmic gymnastics—as a medium for enhancing students' critical thinking skills. Conducted as true experimental research with a quantitative descriptive approach, the study employed a time-series design involving three consecutive rhythmic gymnastics learning sessions using the SENSITIF (Senam Siswa Kreatif) program. The program emphasizes creative movement tasks designed to stimulate both physical and cognitive development. A total of 26 eighth-grade students from Junior High School 2 Pengasih, Yogyakarta, participated in the study, consisting of 13 female and 13 male students. Students' critical thinking performance was assessed through structured observational instruments embedded in the SENSITIF program. The results showed statistically significant improvements in students' critical thinking skills across the three sessions ($p < 0.05$). The highest gain was observed between the first and third sessions, indicating a cumulative effect of the rhythmic movement intervention. These findings suggest that rhythmic gymnastics, when delivered through pedagogically sound and student-centered approaches, can foster critical thinking by engaging students in decision-making, reflection, creativity, and collaboration. The study highlights the need to redefine PE curricula to support holistic learning—where physical, cognitive, and affective domains are developed in synergy.

KEYWORDS

Critical Thinking; Rhythmic Gymnastics; Gross Motor Skills; Physical Education; Cognitive Development

1. INTRODUCTION

In the 21st-century education landscape, critical thinking has emerged as one of the most vital competencies required for learners to thrive in an increasingly dynamic, complex, and globalized world (Kurniawan et al., 2024; Pogrebnaya & Mikhailova, 2023). It is no longer sufficient for students to merely absorb knowledge passively; they must be equipped with the ability to analyze, interpret, evaluate, and apply knowledge in real-world contexts (Pertamawati & Retnowati, 2019). Critical thinking empowers students to make informed decisions, question assumptions, and solve problems creatively—skills that are indispensable across all disciplines and professional domains (Shutaleva, 2023). Educational scholars and policymakers have long emphasized that critical thinking should not be confined to traditionally academic subjects like mathematics, science, or language studies (Nascimento et al., 2019). Instead, it should be nurtured holistically across all areas of learning, including Physical Education (PE). Despite this understanding, the practical integration of critical thinking into PE classes remains a challenge. This difficulty often stems from the perception that physical education focuses solely on bodily movement and physical fitness, rather than cognitive development (Bayu et al., 2022; Niu, 2023). Yet, a growing body of literature suggests that physical activity, especially when it involves decision-making, strategy, expression, and coordination, can significantly contribute to higher-order thinking skills (Aga et al., 2021; Chen, 2024).

Critical thinking is defined as a cognitive process that involves reasoning, judgment, analysis, and problem-solving (Burhanuddin et al., 2019). According to Facione (2000), it encompasses two core dimensions: disposition—the willingness or inclination to engage in thinking activities—and ability—the skill to process and apply critical thought effectively . Disposition reflects affective values such as curiosity, open-mindedness, and persistence, while ability reflects skills often associated with the psychomotor and cognitive domains, such as analyzing, synthesizing, and evaluating information (Liu et al., 2021). This two-part model emphasizes that fostering critical thinking requires both motivational and technical scaffolding—students must not only be capable of thinking critically but also motivated to do so. From this perspective, Physical Education presents untapped potential to integrate both elements. Activities that demand bodily control, coordination, and motor planning can simultaneously stimulate critical thought processes, especially when designed to include elements of creativity, problem-solving, and reflection (Richard et al., 2021). Gross motor activities—which involve large muscle groups and whole-body movements—can serve as powerful tools to develop both cognitive and affective skills. When physical tasks are framed with

open-ended challenges, students are encouraged to make decisions, evaluate their actions, and collaborate—all of which are crucial for critical thinking (Pulgar et al., 2021).

Gross motor development involves a range of fundamental physical skills such as balance, strength, coordination, agility, speed, endurance, and flexibility (Padli et al., 2024). These components not only contribute to physical health and body competence but also relate closely to mental agility and focus. For example, performing complex movements requires attention, spatial awareness, timing, and self-regulation—cognitive processes that are foundational to critical thinking (Pulgar et al., 2021). Furthermore, structured physical activity enhances brain function, supports neural development, and has been shown to improve academic performance and executive functioning in children and adolescents (Pranoto et al., 2024). Among the various types of gross motor activities, rhythmic gymnastics stands out as a unique and multidimensional practice. Rhythmic gymnastics combines coordinated bodily movements with music, rhythm, expression, and choreography (Morgado et al., 2022). Rhythmic movement allows students to explore the boundaries of their physical capabilities while simultaneously engaging in cognitive tasks such as sequencing, memorization, adaptation, and improvisation (Ismail et al., 2021). As students plan and execute routines, they must consider timing, space, and body dynamics. This process activates critical faculties like observation, interpretation, reflection, and problem-solving. Additionally, when students are given autonomy to create or modify their routines, they experience greater ownership over their learning and are more likely to engage in thoughtful decision-making. Critical thinking in Physical Education includes not only responding to physical challenges but also drawing on personal experiences, prior knowledge, and collaborative dialogue (Aartun et al., 2022). When rhythmic gymnastics is delivered in a pedagogically sound manner—where students are encouraged to reflect, adapt, and express themselves—it becomes more than just a physical activity; it becomes a form of embodied thinking.

In Indonesia, as in many educational systems worldwide, critical thinking has been included in the national curriculum as a core competency. However, its implementation often falls short, particularly in non-academic subjects like Physical Education. Many PE classes still emphasize drill-based instruction and mechanical repetition, leaving little room for cognitive engagement. By integrating rhythmic gymnastics as a structured yet flexible approach, educators have the opportunity to revitalize PE instruction and address broader educational goals. This study aims to explore how gross motor activities—particularly rhythmic gymnastics—can serve as a medium to improve students' critical thinking skills. It will investigate the extent to which rhythmic movement tasks

stimulate cognitive engagement, how students respond to problem-solving through motion, and how teachers can design lessons that foster critical reflection and creativity. Through this research, we hope to contribute to the growing discourse on integrated education—where physical and cognitive development are not seen as separate goals, but as mutually reinforcing processes. By emphasizing critical thinking within the context of rhythmic gymnastics, this study underscores the importance of holistic pedagogy that empowers students physically, mentally, and emotionally. The purpose of this study is to examine the impact of rhythmic gymnastics on the enhancement of critical thinking skills in students. The study hypothesizes that engaging in rhythmic gymnastics, with its emphasis on creative movement and problem-solving, will significantly improve students' ability to think critically, reflect, and make decisions.

2. METHODS

2.1. Design and Participants

This study employed an experimental research design using a quantitative descriptive approach. The experimental method was designed to determine causal relationships between variables, specifically to assess the impact of rhythmic gymnastics activities on students' critical thinking skills. A time-series design was used, involving three consecutive trials conducted over three learning sessions.

The participants in this study consisted of 26 eighth-grade students from Junior High School 2 Pengasih, Kulonprogo, Yogyakarta. The sample included 13 female and 13 male students. These students were selected to represent a balanced demographic and participated in the study as research subjects.

2.2. Intervention (Rhythmic Gymnastics Program)

The intervention used in this study was the SENSITIF (Senam Siswa Kreatif) gymnastics program, a creative student exercise routine that integrates rhythmic movement tasks. The program is designed to stimulate both physical and cognitive development through creative and structured movement activities. The rhythmic gymnastics activities in the program were carried out over three consecutive learning sessions, each designed to progressively engage students in physical movement while fostering cognitive engagement and critical thinking.

2.3. Assessment Instrument

To measure the outcomes of the intervention, the study used a critical thinking skill assessment instrument embedded within the SENSITIF program. The instrument employed observational assessment methods to evaluate students' performance in relation to critical thinking indicators during the physical activities. The assessment focused on key components of critical thinking, including decision-making, reflection, problem-solving, and creativity.

2.4. Data Analysis

The Statistical Package for the Social Sciences was used for data analysis. The data were analyzed using two non-parametric statistical tests: the Mann-Whitney Test and the Wilcoxon Test. These tests were chosen due to their suitability for comparing mean scores across the three tests conducted during the intervention. The purpose of using these tests was to determine whether there were significant differences in students' critical thinking skills as a result of the rhythmic gymnastics activities.

3. RESULTS

The effectiveness level of implementing gross motor activities through the SENSITIF rhythmic gymnastics media can be observed from the improvement in students' critical thinking skills during Physical Education lessons. The effectiveness test was conducted using a time-series design, consisting of three continuous trials over three rhythmic gymnastics sessions. Data were collected through teacher observations, using a structured assessment instrument designed to evaluate students' critical thinking performance during the rhythmic gymnastic activities. The instrument was applied during the learning process and focused on observable behaviors that reflect elements of critical thinking. To analyze the effectiveness of the intervention, the Mann-Whitney and Wilcoxon tests were used to compare the results across the three assessment points (Test 1, Test 2, and Test 3). Table 1 assessed whether there were statistically significant differences in mean ranks, indicating growth in students' critical thinking skills over time. In the following, it presents the results of the Mann-Whitney Wilcoxon tests.

Table 1. Mean ranks and sum of ranks comparison

Test Comparison	N	Mean Rank	Sum of Ranks
Test 1	26	19.54	508.0
Test 2		33.46	870.0
Test 2		17.44	453.5
Test 3		35.56	924.5
Test 1		14.71	382.5
Test 3		38.29	995.5

Table 2 shows the results of pairwise comparisons between three tests (Test 1, Test 2, and Test 3) using the Mann–Whitney U test (with the associated Wilcoxon W and Z statistics).

Table 2. Comparison of test scores using Mann–Whitney U and Wilcoxon statistics

Comparison	Mann-Whitney U	Wilcoxon W	Z
Test 1 & Test 2	157.0	508.0	-3.499
Test 2 & Test 3	102.5	453.5	-4.67
Test 1 & Test 3	31.5	382.5	-5.83

The mean ranks for Test 1 and Test 2 were 19.54 and 33.46, respectively, with a Z value of -3.499 and a p-value (Asymp. Sig. 2-tailed) of $0.000 < 0.05$, indicating a significant increase in critical thinking skills between the two tests. The mean ranks for Test 2 and Test 3 were 17.44 and 35.56, respectively, with a Z value of -4.670 and $p = 0.000 < 0.05$, showing further significant improvement. The comparison between Test 1 and Test 3 yielded mean ranks of 14.71 and 38.29, with a Z value of -5.830 and $p = 0.000 < 0.05$, demonstrating the strongest evidence of critical thinking development over the intervention period. These findings indicate a consistent and statistically significant improvement in students' critical thinking skills as a result of the gross motor activity intervention using the SENSITIF rhythmic gymnastics program. The largest effect occurred between the first and third sessions, suggesting cumulative benefits over time.

4. DISCUSSION

This research is significant because it addresses a critical gap in the implementation of 21st-century competencies, particularly the integration of critical thinking into non-academic subjects like Physical Education (PE). In many educational systems, including Indonesia's, critical thinking has been positioned as a core competency in national curricula. However, its practical application often remains confined to academic subjects such as mathematics, science, or language studies. Physical Education is frequently seen as a subject that prioritizes physical fitness and motor skill development, rather than cognitive engagement. This perception limits the potential of PE to contribute to holistic education. The study challenges this narrow view by demonstrating that gross motor activities—especially rhythmic gymnastics—can serve as effective mediums for fostering students' critical thinking skills. By incorporating activities that involve creativity, sequencing, decision-making, and reflection, PE can evolve from a traditionally physical domain into one that also nurtures higher-order cognitive functions.

The results of this study are supported by various prior research findings. For example, found that physical activity has positive effects on cognitive functions, particularly executive functions such as attention, planning, and problem-solving (Festa et al., 2023). These studies confirm that gross motor activities involving strategic movement can enhance brain function and critical thinking. In the same vein, Fong Yan et al. (2024) concluded that cognitively engaging physical activities such as dance or gymnastics not only support physical health but also stimulate mental agility. These findings align with the outcomes of the current study, which showed a statistically significant improvement in students' critical thinking abilities after participating in the rhythmic gymnastics program SENSITIF. Moreover, Suherman et al. (2024) in the Indonesian context found that rhythmic gymnastics can develop attributes such as creativity, discipline, and collaboration, all of which are closely related to critical thinking dispositions such as open-mindedness, persistence, and curiosity.

The implications of this study are far-reaching. First, it suggests that PE curricula need to be redefined to include cognitive and affective development alongside physical goals. Teachers should be encouraged to design lesson plans that incorporate open-ended challenges, encourage reflection, and allow for student autonomy. This requires a shift from drill-based, repetitive instruction to a more exploratory, student-centered learning environment. Second, teacher training programs should integrate modules that equip educators with strategies to nurture thinking skills through movement. Educators must be aware of the cognitive dimensions of motor tasks and learn how to evaluate thinking indicators through alternative assessments, such as observational rubrics. Third, the integration of rhythmic gymnastics into PE not only promotes physical and cognitive growth but also supports cross-disciplinary learning. For instance, students “read” music, “interpret” rhythm, and “express” ideas through movement, engaging in semiotic practices that are analogous to literacy and communication in other subjects.

Another significant implication is related to student motivation and ownership of learning. The creative and reflective nature of the SENSITIF program provides students with a sense of agency, allowing them to make decisions, create routines, and evaluate their own and peers’ performances. This empowerment contributes to deeper learning and a stronger internalization of critical thinking processes. Moreover, by linking physical activity with meaningful cognitive engagement, students are more likely to remain motivated and see the relevance of PE in their overall education. However, the study is not without limitations. One key limitation is the relatively small sample size—only 26 students from one junior high school in Yogyakarta participated in the research. While the findings are statistically significant, they may not be fully generalizable to

broader populations. Future research should involve more participants across different schools and regions to ensure wider applicability. Another limitation lies in the short duration of the intervention, which lasted for only three sessions. Although measurable improvements in critical thinking were observed within this timeframe, a longer intervention period would provide a more robust understanding of the long-term impact of rhythmic gymnastics on cognitive development.

Additionally, the assessment instrument used in this study, while embedded in the SENSITIF program and focused on observable behaviors, may still carry a degree of subjectivity inherent in teacher observations. Future studies could combine observational assessments with self-assessment tools, peer feedback, and pre-post cognitive testing to enhance validity and reliability. It is also important to consider external factors that may have influenced students' performance, such as prior exposure to similar activities, learning styles, or classroom environment. Based on the findings and limitations of this study, several recommendations can be proposed for future research. First, researchers should explore the effects of rhythmic gymnastics on different age groups and educational levels, including early childhood, elementary, and senior high school students. Second, comparative studies could be conducted to evaluate the effectiveness of various types of gross motor activities—such as traditional games, sports, or dance—in developing critical thinking. This would help identify which physical tasks are most conducive to cognitive engagement. Third, qualitative research approaches, such as interviews and focus groups, could be employed to capture students' and teachers’ perceptions of how rhythmic gymnastics influences thinking and learning. These insights could provide a deeper understanding of the mechanisms through which physical activity fosters critical thought. This research provides strong evidence that gross motor activities, specifically rhythmic gymnastics, can play a crucial role in enhancing students’ critical thinking skills within the PE curriculum. By aligning physical, cognitive, and affective learning goals, rhythmic gymnastics becomes more than just an exercise in movement—it becomes a platform for embodied thinking, creative expression, and reflective learning. The findings challenge traditional notions of PE and call for a reimagining of how physical education can contribute to the broader goals of education in the 21st century.

5. CONCLUSIONS

This study demonstrates that gross motor activities, specifically through the implementation of the SENSITIF rhythmic gymnastics program, can significantly enhance students’ critical thinking skills within the context of Physical Education (PE). The intervention, conducted over three consecutive learning sessions using a time-series design, revealed consistent and statistically

significant improvements in students' critical thinking abilities, as measured by structured observational assessments. The results support the idea that physical activities—especially those requiring creativity, coordination, decision-making, and reflection—can stimulate higher-order thinking. The findings challenge the traditional view that PE is solely focused on physical fitness and motor skills, highlighting its potential as a domain for cognitive and affective development. Through rhythmic gymnastics, students are encouraged to plan, create, evaluate, and adapt their movements, engaging both cognitive skills and critical dispositions such as curiosity, persistence, and open-mindedness. The creative nature of the SENSITIF program fosters student agency, motivation, and ownership of learning, aligning physical activity with meaningful cognitive engagement. These outcomes underscore the need for a more integrated and holistic approach to curriculum design in PE, one that includes critical thinking as a key educational objective.

However, the study also acknowledges limitations such as a small sample size and short intervention duration. Despite these constraints, the evidence strongly supports the incorporation of cognitively engaging motor activities into PE instruction. Future research should explore broader implementations, longer durations, and diverse contexts to strengthen generalizability. Ultimately, this study contributes to a growing body of literature advocating for PE as a powerful platform for developing critical thinking and fostering 21st-century competencies.

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ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the students and teachers of Junior High School 2 Pengasih, Yogyakarta, for their participation and cooperation during the study. Special thanks are also extended to the research assistants and academic supervisors who contributed to the successful completion of this research.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

FUNDING

This research received no external funding.

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