



Longitudinal changes in motor competence and social behavior during a progressive traditional-games program

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Received: 6 June 2026; Revised: 15 July 2026; Accepted: 30 August 2026; Available online: 31 August 2026.

Abstract

This study examined longitudinal changes in motor competence and social behavior among elementary school students participating in a progressively structured traditional-games program based on Low Organized Games (LOG), Basic Lead-up Games (BLG), and Advanced Lead-up Games (ALG). A single-cohort longitudinal repeated-measures design was employed with 60 first-grade students aged 6–7 years (33 boys and 27 girls), all of whom completed seven measurement occasions (T0–T6), with no attrition in the analytical sample. Motor competence was assessed using the Test of Gross Motor Development–Third Edition (TGMD-3). In contrast, social behavior was assessed as a continuous, teacher-rated outcome using the School Social Behavior Scales (SSBS). Data were analyzed using descriptive statistics and repeated-measures ANOVA with Greenhouse–Geisser correction and Bonferroni-adjusted pairwise comparisons. Motor competence showed a consistent upward trajectory, with mean TGMD-3 total raw scores increasing from 42.73 at T0 to 91.18 at T6. The continuous social-behavior score also increased from 0.093 at T0 to 0.213 at T6. Significant changes over time were observed for motor competence, $F(2.02, 119.11) = 53,371.75$, $p < .001$, $\eta^2 = .999$, and social behaviour, $F(2.51, 148.26) = 2,307.18$, $p < .001$, $\eta^2 = .975$. All adjacent measurement comparisons were significant for both outcomes after Bonferroni adjustment. These findings show clear upward longitudinal trajectories in motor competence and social behavior during participation in the progressively structured traditional-games program. However, because no control group was included, the observed changes cannot be attributed exclusively to the program. The LOG–BLG–ALG framework represents a promising approach for organizing traditional games within elementary physical education and warrants further evaluation using controlled longitudinal designs.

Keywords: Motor competence, physical education, social behavior, traditional games, longitudinal study.

How to Cite: Sari, Z. N., Nurrochmah, S., & Wiguno, L. T. H. (2026). Longitudinal changes in motor competence and social behavior during a progressive traditional-games program. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, 12(2), 368–385. https://doi.org/10.29407/js_unpgri.v12i2.29330

Authors contribution: a – Preparing concepts; b – Formulating methods; c – Conducting research; d – Processing results; e – Interpretation and conclusions; f – Editing the final version.

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INTRODUCTION

Insufficient physical activity among children remains an important public-health and educational concern because childhood movement experiences contribute to physical health, motor development, and continued participation in active lifestyles. Globally, a large proportion of school-aged children do not achieve recommended levels of physical activity ([World Health Organization, 2020](#)). Screen-based behaviors have also become increasingly prominent in children's daily routines and have been associated with sedentary time and fewer opportunities for active play in several populations ([Chinapaw et al., 2015](#); [Sambo et al., 2023](#)). These patterns do not imply that digital technology directly causes physical inactivity. Rather, screen-based activities may reduce opportunities for movement-rich play when they replace active forms of recreation. This highlights the importance of school-based programs that provide children with regular and meaningful opportunities for movement during an important period of physical and social development.

This concern is particularly relevant to elementary physical education in Indonesia. Physical Education, Sports, and Health (Pendidikan Jasmani, Olahraga, dan Kesehatan [PJOK]) provides a structured curricular context in which students can systematically engage in movement learning while interacting with peers. Indonesian physical education research nevertheless indicates considerable variation in instructional practices across schools, suggesting continued opportunities to develop more engaging, developmentally appropriate, and culturally meaningful learning experiences ([Supriadi, 2014](#)). Indonesia also has a wide range of traditional games involving locomotor movement, object manipulation, cooperation, shared rules, and peer interaction. Integrating these culturally familiar activities into structured PJOK may therefore connect movement-learning objectives with forms of play embedded within students' broader sociocultural environment ([Gustian et al., 2025](#); [Mashuri, 2022](#)).

The elementary-school years are particularly important for motor development. Fundamental movement skills, including locomotor and ball skills, provide a foundation for participation in more complex physical activities and sports (Park et al., 2020; Woods et al., 2024). Motor competence and physical activity are developmentally related: greater movement competence may support children's confidence and willingness to participate, while repeated participation provides further opportunities to practice and refine motor skills. Elementary physical education therefore provides an important setting for repeated and progressively challenging movement experiences.

Motor development, however, represents only one dimension of learning in physical education. School-based physical activity typically occurs in interpersonal, rule-governed situations in which children interact with peers, follow shared rules, take turns, cooperate, compete, and make decisions. Social behavior in this context can be understood through students' observable patterns of social functioning during interactions with peers, teachers, and the broader school environment. This conceptualization is consistent with the School Social Behavior Scales (SSBS), which assess socially relevant behaviors in school settings through teacher ratings (Garrote et al., 2024). Accordingly, social behavior in the present study refers specifically to observable behavior within school-related interpersonal interactions as represented by the SSBS. Motor competence and social behavior were examined concurrently because physical-education activities involve both movement and social demands. However, the two variables were treated as distinct outcomes, and their parallel assessment was not intended to imply a causal or statistical relationship.

Traditional games provide a relevant context for integrating these movement and social experiences. Many traditional games involve locomotor or object-control skills alongside cooperation, communication, adherence to shared rules, and responses to other players. Previous research has associated participation in traditional games with motor development and social

or character-related outcomes among school-aged children (Mashuri, 2022; Mustara et al., 2025; Purwanto et al., 2025). Culturally familiar activities may also make learning more meaningful by connecting school-based movement experiences with forms of play embedded within students' social and cultural environments (Sakti et al., 2024). In the present study, however, cultural familiarity is treated as a contextual characteristic rather than an outcome. Cultural preservation, cultural responsiveness, engagement, and social connectedness are therefore not assumed to result automatically from participation in traditional games because such outcomes would require direct measurement.

The educational value of traditional games also depends on how learning activities are organized. Modified traditional games can involve intentional adjustments to rules, movement demands, task complexity, equipment, tactical requirements, and social interaction, based on students' developmental characteristics and instructional objectives. In the present study, progression refers specifically to planned increases in movement complexity, rule complexity, tactical requirements, cooperation demands, and decision-making across learning experiences. Such organization allows relatively simple movement and interaction patterns to precede more complex game situations while retaining the playful characteristics of traditional activities. Thus, traditional games are positioned not merely as recreational activities but as structured learning experiences within physical education.

Based on this rationale, modified Indonesian traditional games were organized through three progressive levels: Low Organized Games (LOG), Basic Lead-up Games (BLG), and Advanced Lead-up Games (ALG). The LOG–BLG–ALG sequence served as the program's pedagogical structure rather than a set of independent experimental conditions. LOG emphasized relatively simple movement patterns and rules; BLG introduced more structured skill combinations and game demands; and ALG incorporated more complex movement, tactical, decision-making, and interaction requirements.

Traditional games originating from different regions of Indonesia were positioned within these levels according to their movement characteristics, interaction demands, developmental appropriateness, and cultural representation. The program's defining characteristic was therefore the systematic progression of movement and social demands within traditional-game activities.

Despite growing interest in traditional games, several gaps remain. First, motor and social outcomes have often been examined separately, providing limited evidence about how both domains change within the same physical-education experience (Mashuri, 2022; Purwanto et al., 2024). Second, evidence remains limited regarding the systematic organization of traditional games according to progressively increasing motor and interaction demands (Irmansyah et al., 2020; Mustara et al., 2025). Third, much of the available research has relied on cross-sectional or pretest–posttest designs, leaving relatively little evidence about changes across multiple measurement occasions (Irmansyah et al., 2020; Suryadi et al., 2025).

Addressing these gaps requires a longitudinal perspective that can document changes across repeated measurement occasions while avoiding causal interpretations the design cannot support. The distinctive contribution of the present study lies in concurrently assessing motor competence and social behavior across seven measurement occasions within a three-year, progressively structured traditional-games program. This repeated-measures approach provides information about the direction and pattern of change within the same cohort rather than attempting to establish the comparative effectiveness of the program. It also avoids treating LOG, BLG, and ALG as independent experimental conditions because progression through these phases occurred concurrently with chronological development and schooling.

Therefore, this study aimed to examine longitudinal changes in motor competence and social behavior among elementary school students across seven measurement occasions during participation in a three-year,

progressively structured traditional-games program organized through LOG, BLG, and ALG. By examining both outcomes concurrently, the study seeks to provide evidence regarding their longitudinal trajectories during program participation and to contribute to the development of progressively organized traditional-game approaches within elementary physical education.

METHOD

Study Design and Participants

This study employed a single-cohort longitudinal repeated-measures design to examine changes in motor competence and social behavior among elementary school students participating in a progressively structured traditional-games program. The same cohort was assessed seven times across three academic years: T0 in July 2022 at the beginning of Grade 1; T1 in December 2022 and T2 in June 2023 during Grade 1; T3 in December 2023 and T4 in June 2024 during Grade 2; and T5 in December 2024 and T6 in June 2025 during Grade 3. T0 represented baseline, T1–T2 the Low Organized Games (LOG) phase, T3–T4 the Basic Lead-up Games (BLG) phase, and T5–T6 the Advanced Lead-up Games (ALG) phase. These phases were sequential components of the same program rather than independent experimental conditions.

Using purposive sampling, we assessed 84 first-grade students for eligibility because participation required predefined eligibility criteria and availability for longitudinal participation. Of these, 24 were not enrolled: 10 did not meet age, grade, or participation criteria; six lacked parental or guardian consent; five had health conditions or temporary limitations that restricted safe participation; and three were unable or unwilling to commit to the program. The final sample comprised 60 students aged 6–7 years (33 boys and 27 girls). Safe participation was determined from parental or guardian reports, available school health records, teacher confirmation, and observation. Students with temporary illness or injury resumed participation when safe, and activity

adjustments were provided when required. All participants completed T0–T6 (n = 60 at each occasion), resulting in 100% retention, no missing outcome data, and no need for imputation.

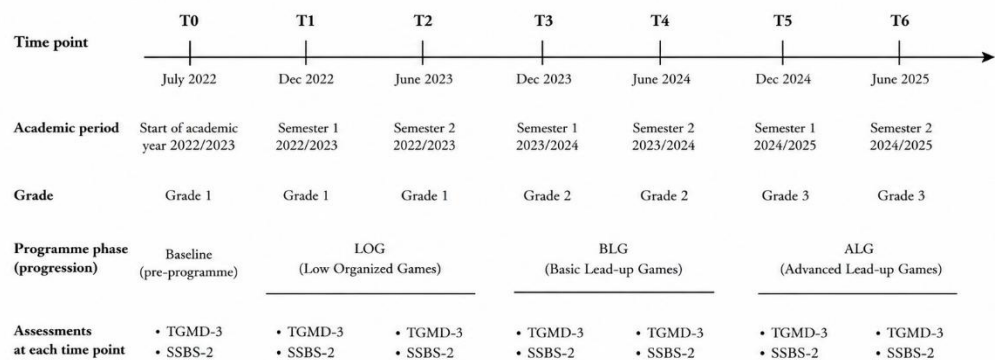


Figure 1. Longitudinal study timeline and progression of the LOG–BLG–ALG progressively structured traditional-games program across T0–T6.

Progressively Structured Traditional-Games Program

The program consisted of modified Indonesian traditional games progressively organized through LOG, BLG, and ALG and incorporated into regular Physical Education, Sports, and Health (PJOK) lessons. Games from western, central, and eastern regions of Indonesia were selected according to movement characteristics, social-interaction demands, developmental appropriateness, and cultural representation. Progression involved increasing movement complexity, rule structure, tactical decision-making, cooperation, and social-interaction demands. LOG emphasized relatively simple movement patterns, rules, and peer interaction; BLG introduced more structured skill combinations, rules, and cooperative demands; and ALG involved more complex movement, tactical decision-making, and interaction requirements.

Sessions lasted approximately 30 minutes and were conducted once to twice per week as part of regular PJOK. The research team primarily delivered the program, with assistance from five teachers who received a 60-minute orientation on program objectives, activity organization, and the LOG–BLG–ALG sequence. Implementation was documented through teacher reports and

session logs covering attendance, session duration, program phase, activities, modifications, implementation constraints, and safety-related events. No quantitative fidelity score was available; therefore, the records documented program delivery rather than numerical adherence.

Measures and Data Collection

Motor Competence

Motor competence was assessed using the Test of Gross Motor Development–Third Edition (TGMD-3), covering locomotor and ball skills. Participants received a demonstration and one practice trial before completing two formal trials for each skill. Performance criteria were scored 1 when demonstrated and 0 when not demonstrated, producing a continuous total raw score of 0–100 (locomotor = 46; ball skills = 54). Researcher-generated performance categories were not used.

All formal performances were video-recorded and independently scored by the same two trained assessors across T0–T6. Before scoring, the assessors completed two training sessions totaling five hours, conducted by the principal researcher, covering TGMD-3 administration, scoring, video-based practice, and calibration. Assessors were required to achieve at least 80% agreement during practice scoring before formal assessment. Inter-rater reliability was evaluated during assessor calibration; however, the final ICC value was not available in the verified study records and is therefore not reported.

Social Behaviour

Social behavior was assessed using the 32-item Social Competence Scale of the School Social Behavior Scales, Second Edition (SSBS-2), comprising Peer Relations (14 items), Self-Management/Compliance (10 items), and Academic Behavior (8 items). Items were rated from 1 to 5, producing a possible raw score of 32–160 and analyzed continuously without researcher-generated cut-offs. Grade 1 homeroom teachers completed ratings at T0–T2, Grade 2 teachers at T3–T4, and Grade 3 teachers at T5–T6.

At each measurement occasion, TGMD-3 performances were administered using the same procedures, video-recorded, and independently scored, while corresponding homeroom teachers completed SSBS-2 ratings. Unique participant identification codes linked repeated observations across T0–T6 while maintaining confidentiality. BMI and PAQ-C were used only to describe baseline participant characteristics and were not included as longitudinal outcomes or covariates.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics version 25. Means and standard deviations were calculated for continuous variables, while frequencies and percentages were used for categorical characteristics. Normality was examined using the Shapiro–Wilk test, and potential extreme or influential observations were screened using boxplots, standardized z-scores, standardized residuals, and verification against the original dataset. No observations required exclusion.

Motor competence and social behavior were analyzed separately using one-way repeated-measures ANOVA across T0–T6, with measurement occasion as the within-subject factor. LOG, BLG, and ALG were treated as sequential program phases rather than independent conditions; therefore, phase-specific causal effects were not estimated. Mauchly's test assessed sphericity, and the Greenhouse–Geisser correction was applied when it was violated. Significant omnibus effects were followed by Bonferroni-adjusted pairwise comparisons, with adjusted p-values and 95% confidence intervals reported. Partial eta squared (η^2) represented the omnibus effect size, with statistical significance set at $p < .05$.

Ethical Considerations

Ethical approval was obtained from Universitas Negeri Malang (No. 19021/UM.213/X2/062). Written parental or guardian consent and age-appropriate child assent were obtained. Participation was voluntary, and

unique identification codes were used to maintain confidentiality and link repeated observations across T0–T6.

RESULTS

Participant Characteristics

All 60 participants completed the seven measurement occasions from T0 to T6, resulting in a complete longitudinal dataset with no attrition or missing outcome data. The sample consisted of 33 boys (55.0%) and 27 girls (45.0%). At baseline, 21 students (35.0%) were 6 years old, and 39 students (65.0%) were 7 years old. Baseline physical activity, assessed using the PAQ-C, had a mean score of 1.80 (SD = 0.26).

Motor Competence Across Measurement Occasions

Motor competence increased progressively across the seven measurement occasions. The mean TGMD-3 total raw score increased from 42.73 (SD = 2.48) at T0 to 53.53 (SD = 3.21) at T1 and 61.57 (SD = 3.13) at T2. Scores continued to increase to 71.53 (SD = 3.21) at T3, 79.57 (SD = 3.55) at T4, 87.18 (SD = 3.52) at T5, and 91.18 (SD = 3.52) at T6.

Table 1. Motor competence scores across T0–T6 (N = 60)

Measurement	Programme stage	Mean	SD
T0	Baseline	42.73	2.48
T1	LOG	53.53	3.21
T2	LOG	61.57	3.13
T3	BLG	71.53	3.21
T4	BLG	79.57	3.55
T5	ALG	87.18	3.52
T6	Final assessment	91.18	3.52

Note. Scores represent TGMD-3 total raw scores. LOG = Low Organized Games; BLG = Basic Lead-up Games; ALG = Advanced Lead-up Games.

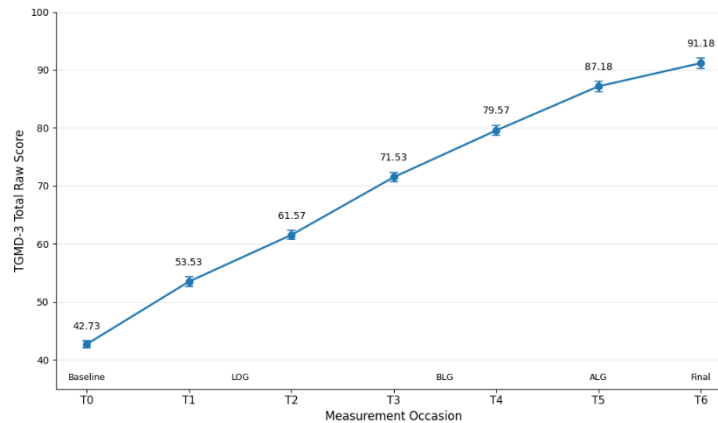


Figure 2. Mean TGMD-3 total raw scores across the seven measurement occasions.

A one-way repeated-measures ANOVA was conducted to examine differences in motor competence across the seven measurement occasions. Mauchly's test indicated that the assumption of sphericity was violated; therefore, the Greenhouse–Geisser correction was applied. The corrected analysis showed a statistically significant effect of time on motor competence, $F(2.02, 119.11) = 53,371.75$, $p < .001$, $\eta p^2 = .999$.

Bonferroni-adjusted comparisons between consecutive measurement occasions showed significant increases throughout the study period. Mean differences were 10.80 points between T0 and T1, 8.03 between T1 and T2, 9.97 between T2 and T3, 8.03 between T3 and T4, 7.62 between T4 and T5, and 4.00 between T5 and T6.

Table 2. Bonferroni-adjusted adjacent comparisons for motor competence

Comparison	Mean difference	Adjusted 95% CI	Adjusted <i>p</i>
T1 – T0	10.80	10.50–11.10	< .001
T2 – T1	8.03	7.92–8.15	< .001
T3 – T2	9.97	9.72–10.22	< .001
T4 – T3	8.03	7.87–8.19	< .001
T5 – T4	7.62	7.40–7.83	< .001
T6 – T5	4.00	4.00–4.00	< .001

The largest adjacent change was observed between T0 and T1, whereas the smallest difference occurred between T5 and T6.

Social Behavior Across Measurement Occasions

Social behavior also showed an overall upward pattern across the seven assessments. Based on the individual Excel data, the mean continuous social-

behavior score increased from 0.093 (SD = 0.008) at T0 to 0.126 (SD = 0.010) at T1 and 0.136 (SD = 0.008) at T2. Mean scores subsequently increased to 0.163 (SD = 0.011) at T3, 0.177 (SD = 0.008) at T4, 0.190 (SD = 0.010) at T5, and 0.213 (SD = 0.011) at T6.

Table 3. Social-behaviour scores across T0–T6 (N = 60)

Measurement	Programme stage	Mean	SD
T0	Baseline	0.093	0.008
T1	LOG	0.126	0.010
T2	LOG	0.136	0.008
T3	BLG	0.163	0.011
T4	BLG	0.177	0.008
T5	ALG	0.190	0.010
T6	Final assessment	0.213	0.011

Note. Continuous scores derived from the individual social-behavior dataset were used. Researcher-generated descriptive categories were not used for inferential interpretation.

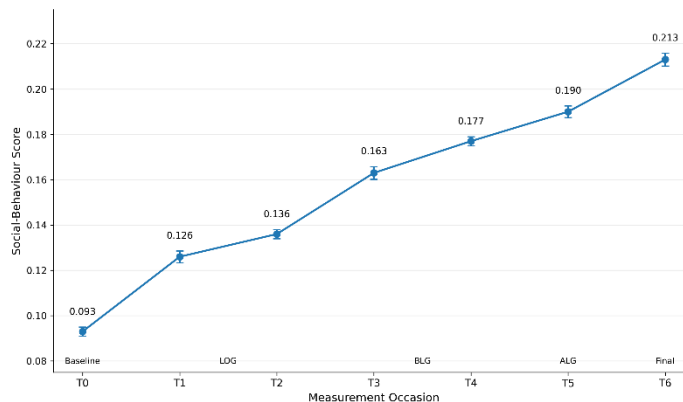


Figure 3. Mean social-behavior scores across the seven measurement occasions.

Repeated-measures ANOVA indicated that social-behavior scores differed significantly across measurement occasions. Because the assumption of sphericity was violated, Greenhouse–Geisser-corrected results were used. The analysis showed a significant effect of time, $F(2.51, 148.26) = 2,307.18$, $p < .001$, $\eta^2 = .975$.

Bonferroni-adjusted comparisons showed significant differences between all consecutive measurement occasions. The mean increase was 0.0325 from T0 to T1, 0.0108 from T1 to T2, 0.0268 from T2 to T3, 0.0138 from T3 to T4, 0.0131 from T4 to T5, and 0.0228 from T5 to T6; all adjusted comparisons were statistically significant at $p < .001$.

Table 4. Bonferroni-adjusted adjacent comparisons for social behavior

Comparison	Mean difference	Adjusted 95% CI	Adjusted <i>p</i>
T1 – T0	0.0325	0.0291–0.0359	< .001
T2 – T1	0.0108	0.0081–0.0135	< .001
T3 – T2	0.0268	0.0238–0.0297	< .001
T4 – T3	0.0138	0.0092–0.0184	< .001
T5 – T4	0.0131	0.0082–0.0179	< .001
T6 – T5	0.0228	0.0206–0.0250	< .001

DISCUSSION

The findings showed clear upward trajectories in both motor competence and social behavior across the seven measurement occasions. These changes were statistically significant over time, although they represent within-cohort longitudinal patterns rather than program effects because no control or comparison group was included. The results therefore provide evidence of developmental change during participation in the LOG–BLG–ALG program but do not establish that the program alone produced the observed trajectories.

Motor competence increased between consecutive measurement occasions, with the largest adjacent change occurring between T0 and T1 and the smallest between T5 and T6. This trajectory is consistent with evidence that traditional-game activities provide repeated opportunities to practice fundamental movement skills (Aliriad et al., 2024; Rahmani et al., 2024), while longitudinal evidence indicates that motor competence can develop considerably from early to middle childhood (Koolwijk et al., 2024). The progressively increasing movement, rule, tactical, and interaction demands of LOG–BLG–ALG provide a plausible pedagogical context for the observed trajectory by allowing previously practiced skills to be applied under increasingly complex task conditions (Firdaus et al., 2026; Irfan & Nasrullah, 2026). Nevertheless, LOG, BLG, and ALG were sequential program phases rather than independently compared experimental conditions. Their progression also coincided with chronological aging, schooling, regular physical education, and maturation; therefore, higher scores during later phases cannot establish that ALG was more effective than BLG or LOG.

The large magnitude of the motor-competence effect should be interpreted cautiously. Statistical significance and effect-size magnitude do not by themselves establish educational or normative importance, particularly in the absence of a comparison group. The high final TGMD-3 scores and progressively smaller adjacent changes toward T6 may reflect developmental deceleration, reduced variability at higher scores, or a possible ceiling effect.

Social behavior similarly showed an upward trajectory, with significant changes between consecutive assessments. The traditional games used in the program required peer interaction, shared rules, turn-taking, coordinated actions, and collective participation, providing a plausible context for the observed changes. Previous studies have also reported social outcomes associated with traditional-game activities among children (Aulia et al., 2022; Mustara et al., 2025; Shandi et al., 2026). However, these interaction characteristics were not tested as mechanisms, and the study did not separately analyze cooperation, communication, responsibility, sportsmanship, or other behavioral dimensions. The findings therefore indicate change in the continuous overall social-behavior outcome rather than improvement in each component of social behavior. Maturation, schooling, peer experiences, and increasing familiarity with social rules also remain alternative explanations, while teacher ratings may have been influenced by familiarity with students or expectations regarding their development.

A key contribution of this study is the concurrent assessment of motor competence and social behavior within the same cohort over three academic years. Although both outcomes increased, their parallel trajectories do not establish a statistical relationship because the study did not analyze associations between changes in the two outcomes. The findings therefore indicate co-occurring longitudinal changes rather than evidence that change in one domain produced change in the other. The use of Indonesian traditional games also provides a culturally situated context, but cultural identity, knowledge, engagement, and perceived relevance were not measured.

Accordingly, the cultural origin of the games should be understood as a contextual characteristic rather than evidence of cultural preservation or responsiveness (Yulianto et al., 2025).

From a pedagogical perspective, the LOG–BLG–ALG framework illustrates how traditional games can be systematically organized through progressive movement, rule, tactical, and interaction demands. Similar structured approaches have been considered useful for aligning traditional games with motor and social learning objectives (Irfan & Nasrullah, 2026; Irwanto et al., 2025). Its contribution lies in providing a framework for organizing traditional games rather than demonstrating superiority over conventional physical education or other game-based approaches. The seven repeated assessments further provide information about patterns of change that would not be visible in a conventional pretest–posttest design. However, these trajectories cannot be considered sustained program effects because no post-program follow-up was conducted.

Several limitations should be considered. The absence of a control group prevents program-related changes from being separated from maturation, schooling, regular physical education, and other physical-activity experiences, while the single-school sample limits generalisability. Using the same non-blinded assessors across repeated motor assessments may have introduced assessment bias, and teacher-rated social behavior may have been affected by familiarity or expectation effects. Repeated motor assessment and the high final TGMD-3 scores also raise the possibility of performance familiarity and ceiling effects. Future studies should therefore use controlled multi-school longitudinal designs, formal fidelity assessment, independent or blinded assessors, and post-program follow-up. Further research could also examine locomotor and ball-skill trajectories separately, analyze validated dimensions of social behavior, and investigate associations between motor and social changes.

CONCLUSION

Motor competence and social behavior showed clear upward trajectories across seven measurement occasions during participation in the progressively structured LOG–BLG–ALG traditional-games program. The study contributes longitudinal evidence by examining both outcomes within the same cohort over three academic years. However, because no control group was included, the observed changes cannot be attributed exclusively to program participation. The LOG–BLG–ALG framework provides a structured way to organize traditional games in elementary physical education, but its comparative effectiveness remains to be established. Future controlled, multi-school longitudinal studies with post-program follow-up are needed to determine whether similar patterns occur across settings and persist over time.

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