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Enhancing Elementary Students' Motor Skills through a Game-Based Athletics Activity Model

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Abstract

Study purpose. This study aimed to examine the effect of the Game-Based Athletics Activity Model on improving the locomotor motor skills of elementary school students during Physical Education, Sports, and Health (PJOK) lessons.
Materials and methods. A one-group pretest–posttest design was used with 30 fifth-grade students selected through total sampling. Participants completed an eight-week Game-Based Athletics Activity Model program. I used the TGMD-3 Locomotor Subtest to see how well the subject could do locomotor activities. For the data analysis I applied both the Shapiro-Wilk test and the Wilcoxon Signed Rank Test. I considered $p < .05$ as significant.
The results showed that after the intervention there was an improvement in the students locomotor motor abilities. Before the intervention the average locomotor score was 9.83 (SD = 1.82). After the intervention the average locomotor score rose to 20.57 (SD = 1.22). All of the students who took part in the game-based program showed higher locomotor performance according to the Wilcoxon signed-ranks test. The test results revealed a significant difference, between the students pre-test and post-test scores ($Z = -4.782$ $p < .001$).
Conclusions. The Game Based Athletics Activity Model worked well in helping elementary school students get better at movement skills like running, jumping and crawling. This shows that mixing athletics with game like activities in education is a good way to teach these skills. It keeps kids matched to their age and abilities. Actually helps them improve. Using games to teach movement makes learning feel more natural and enjoyable for students. Teachers can use this method to help kids grow stronger, in their skills while having fun.

Keywords: Game-based athletics, Motor skills, Physical education, Elementary school.

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Introduction

Human development begins during the period, before birth. Human development continues after a baby is born. Human development moves forward as the motor system grows and develops in stages (Karadeniz et al., 2023). Human development is guided by practice. The movement experiences a child has shape how a child learns to move. These experiences help the system change and adapt. The ability to change is called neuroplasticity. Neuroplasticity means the brain can reorganize itself. Neuroplasticity changes how it works and how its pathways connect when someone learns something or repeats an action over and over. (Shi & Feng, 2022; Malling et al., 2025). I think motor skills are a part that helps a person do different physical activities (Ritonga et al., 2024). I observe that in school motor skills act as the base for building advanced movement abilities, better fitness and, for students to join many physical activities and sports (Chaeroni et al., 2022).

Physical education has a role, in helping students grow motor skills. In my experience Physical education does this by giving students structured, systematic and age-right movement experiences (Sackett & Edwards, 2019; Syaflin et al., 2021; Pradipta et al., 2023; Lanos, 2024). Many teachers use teaching methods to boost gross motor skills in Physical education (Ericsson & Karlsson, 2012; Zhao et al., 2024; Magistro et al., 2022; Nazari et al., 2025). Gross motor skills are essential because they support students' ability to perform daily activities while contributing to their overall physical and motor development.

The development of motor skills among elementary school students remains a challenge in education. Preliminary observations conducted during Physical Education, Sports and Health (PJOK) lessons in a fifth-grade class at SD Negeri 1 Talang Kelapa, Banyuasin revealed that many students experienced difficulties in performing combinations of movement skills including running, jumping, changing direction and maintaining balance during physical activities. The learning process was predominantly characterized by technique-based practice that emphasized repetitive movement drills.

Consequently students engagement and active participation, in the learning process remained suboptimal.To address these challenges, a Game-Based Athletics Activity Model was developed by integrating fundamental athletics movements into structured play-based learning activities that are aligned with children's developmental characteristics. Athletics was selected because its core activities represent complementary domains of fundamental movement skills running and jumping as locomotor skills and throwing as an object-control skill providing a logical progression from whole-body locomotor control toward more complex object maniplation and coordination (Duncan et al., 2019). Consequently, athletics instruction at the elementary school level should emphasize enjoyable and developmentally appropriate game-based experiences rather than repetitive technical drills. I believe that this approach will raise students learning motivation encourage participation and help students develop fundamental motor skills in a way that matches their growth and development (Fahmi et al., 2026). The model was built to create a fun and student-centered learning environment that makes students want to engage more in every part of the learning journey. By adding running jumping and throwing into organized game-like activities the model gives students richer and more varied movement experiences, than normal technique-based teaching. These varied movement stimuli should help students build their motor skills while also keeping students learning motivation high encouraging students to take part and giving students meaningful learning experiences. This approach will keep students learning motivation keep active participation high and help students keep their fundamental motor skills growing. (Jakubík & Broďáni, 2023; Kardi & Cs, 2025).

The Game-Based Athletics Activity Model consists of five games: Sprint Bendera Nusantara, Estafet Kilat Ceria, Reaksi Petir Sprint, Lintasan Ninja Sprint and Sprint Juara Mini. These games gradually combine running, jumping, coordination and complementary throwing-

and-catching tasks so that students can build locomotor skills. Yet evidence that the Game-Based Athletics Activity Model truly improves students motor skills is still scarce. Earlier work mostly looked at how to build and validate the Game-Based Athletics Activity Model, not at how the Game-Based Athletics Activity Model works for students. This gap tells us we must do research to see if the Game-Based Athletics Activity Model can really boost motor skill development. Therefore this study seeks evidence by testing a five-game model that aims to improve locomotor skills, in elementary students. (Sun, 2024; Yin et al., 2025).

Materials and methods

Type of Research

A one-group pretest–posttest experimental design was employed, whereby all participants received the same intervention and outcomes were assessed before and after the intervention without the inclusion of a control group (Priadana, & Sunarsi, 2021). Motor skill performance was assessed before (pretest) and after (posttest) the intervention to determine changes attributable to the treatment. All participants were given the intervention using the Game-Based Athletics Activity Model. This design was seen as suitable for testing how well an educational intervention works in a real school setting. It was especially useful when a control group could not be included. This was due, to number of participants or ethical issues (Creswell, J. W., & Creswell, 2017).

Study participants

I was part of the team that carried out the study at SD Negeri 1 Talang Kelapa in Banyuasin Regency, South Sumatra, Indonesia. The study involved 30 fifth-grade students, all aged between 10 and 11 years who were chosen by sampling. The study set the following inclusion criteria: (1) enrollment in the fifth grade, (2) regular attendance in Physical Education, Sports and Health (PJOK) classes, (3) good physical health (4) written informed consent, from parents or legal guardians and (5) willingness to participate in all stages of the study. The study excluded any students who had neurological disorders, who were injured during the study period or who did not finish both the pretest and posttest assessments.All study procedures followed the principles set out in the Declaration of Helsinki.

The study guaranteed participant safety kept data confidential and allowed participants to withdraw from the study at any time without impacting their school activities (Association, 2013).(Association, 2013).

Study organization

Research Procedures

The study was conducted over an eight-week period and consisted of four phases: preparation, pretest, intervention, and posttest. The preparation phase included the development of instructional materials, expert validation of the Game-Based Athletics Activity Model, preparation of the research instruments, and coordination with the school and physical education teachers. Baseline motor skills were then assessed using the Test of Gross Motor Development–Third Edition (TGMD-3).

The intervention comprised eight instructional sessions, each lasting 2 × 35 minutes. Each session began with a warm-up then we moved into game-based athletics activities. Finished with a cool-down that included reflection. The learning activities were arranged step by step starting with tasks and growing to more complex ones. This helped elementary school students develop locomotor skills in a way that fits their development.

After the intervention participants took a posttest using the TGMD-3 instrument and the same standardized assessment procedures that were used during the pretest. This approach let us see the changes, in motor skill performance objectively.

Research Instrument

Motor skill performance was assessed using the Test of Gross Motor Development–Third Edition (TGMD-3), developed by Motor skill performance was assessed using the Test of Gross Motor Development–Third Edition (TGMD-3) developed by Ulrich (2019). The TGMD-3 is an internationally recognized standardized assessment instrument for evaluating fundamental movement skills in school-aged children and has demonstrated strong construct validity, reliability, and internal consistency across diverse child populations. (Ulrich, 2019 ; Hulteen et al., 2020 ; Zhu et al., 2025). The TGMD-3 comprises two subtests: Locomotor Skills and Ball Skills (Object Control). This study employed only the Locomotor Skills subtest, as it corresponds to the focus of the Game-Based Athletics Activity Model, which is designed to develop fundamental locomotor skills through athletics-based activities.

Table 1. TGMD-3 Instrument Components

Domain	Skill	Assessment Purpose
Locomotor	Running	To assess the ability to run with proper coordination and technique.
Locomotor	Galloping	To assess coordination during the galloping movement pattern.
Locomotor	Hopping	To assess the ability to hop on one foot while maintaining balance and coordination.
Locomotor	Skipping	To assess coordination during the skipping movement pattern.
Locomotor	Horizontal Jump	To assess the ability to perform a standing horizontal jump with appropriate technique.
Locomotor	Sliding	To assess the ability to perform coordinated lateral sliding movements.

Table 2. TGMD-3 Locomotor Skills Scoring Criteria

Score	Scoring Criteria
1	Performance criterion correctly demonstrated.
0	Performance criterion not correctly demonstrated.

Participants were provided with a demonstration of each movement by the examiner and allowed one practice trial. Each participant then performed two test trials for every locomotor skill. Each performance criterion was scored as **1** if executed correctly according to the TGMD-3 guidelines and **0** if the criterion was not met. Scores from the two trials were summed to obtain the score for each skill, and the skill scores were subsequently aggregated to produce the total locomotor score. Higher total scores indicated better locomotor motor skill performance (Ulrich, 2019).

Assessments were carried out by two trained examiners who were familiar, with the TGMD-3 administration and scoring guidelines. I felt that keeping assessments objective was important so an observer calibration session was held before data collection to ensure scoring consistency. When examiners had scores examiners discussed until examiners reached a consensus.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics were used to summarize the data, including the mean, standard deviation (SD), minimum and

maximum values, and 95% confidence intervals (95% CI). Prior to hypothesis testing, data normality was assessed using the Shapiro–Wilk test, as the study sample comprised fewer than 50 participants (Field, 2018). Differences between the pretest and posttest scores were analyzed using a paired-samples *t*-test when the data met the assumption of normality. When this assumption was violated, the Wilcoxon signed-rank test was used as the non-parametric alternative.

In addition to significance testing, the effect size (Cohen's *d*) was calculated to determine the magnitude of the effect of the Game-Based Athletics Activity Model on students' motor skill improvement. The magnitude of the effect size was interpreted according to the following thresholds: trivial (0.01), small (0.20), medium (0.50), large (0.80), very large (1.20), and extremely large (2.00) (Sawilowsky, 2009). Seluruh analisis statistik dilakukan pada taraf signifikansi p < 0,05. Statistical significance was set at $p < 0.05$ for all analyses.

Results

Assessments were carried out by two trained examiners who were familiar, with the TGMD-3 administration and scoring guidelines. I felt that keeping assessments objective was important so an observer calibration session was held before data collection to ensure scoring consistency. When examiners had scores examiners discussed until examiners reached a consensus. The mean score increased from 9.83 (SD = 1.82) at pretest to 20.57 (SD = 1.22) at posttest, representing a mean increase of 10.74 points. These raw scores were derived from the performance-criterion scores across the six locomotor skills assessed by the TGMD-3 and were used as the primary outcome measure because the intervention specifically targeted students' locomotor motor skills.

Table 3. Descriptive Statistics of Pretest and Posttest Scores

Variable	n	Mean	SD	Minimum	Maximum
Pretest	30	9.83	1.82	6	13
Posttest	30	20.57	1.22	18	23

All locomotor skill indicators showed performance after the Game-Based Athletics Activity Model was used.

Before testing the hypothesis we checked whether the data followed a distribution with the Shapiro–Wilk test because we had less, than 50 participants. The results helped decide if parametric or non-parametric statistical analyses should be used.

Table 4. Results of the Shapiro–Wilk Normality Test

Variable	W	p
Pretest	0.955	0.230
Posttest	0.923	0.032

The results of the Shapiro–Wilk normality test are presented in Table 4. The pretest scores were normally distributed ($W = 0.955$, $p = 0.230$), whereas the posttest scores deviated significantly from a normal distribution ($W = 0.923$, $p = 0.032$). Because the normality assumption was not satisfied for the posttest data, differences between the pretest and posttest scores were analyzed using the Wilcoxon signed-rank test, a non-parametric test for paired samples. This approach ensured that the statistical analysis was appropriate for the distributional characteristics of the data.

Differences in locomotor motor skill scores before and after the implementation of the Game-Based Athletics Activity Model were analyzed using the Wilcoxon signed-rank test.

Table 5. Wilcoxon Signed-Rank Test: Rank Statistics

Ranks	n	Mean Rank	Sum of Ranks
Negative Ranks	0	0.00	0.00
Positive Ranks	30	15.50	465.00

All participants showed improved scores following the intervention, as evidenced by the presence of 30 positive ranks and the absence of both negative ranks and tied scores.

Tabel 6. Wilcoxon Signed-Rank Test Statistics

Statistik	Nilai
Wilcoxon Statistic (W)	0.00
Z	-4.782
Asymp. Sig. (2-tailed)	<0.001

The Wilcoxon signed-rank test revealed a highly significant difference between the pretest and posttest scores ($Z = -4.782$, $p < 0.001$). Therefore, the null hypothesis was rejected, indicating that the Game-Based Athletics Activity Model significantly improved the locomotor motor skills of elementary school students.

To further illustrate the changes in students' locomotor motor skill performance following the implementation of the Game-Based Athletics Activity Model, a comparison of the mean pretest and posttest scores is presented in Table 7.

Tabel 7. Comparison of Pretest and Posttest Locomotor Motor Skill Scores

Measurement	Mean (SD)	Mean Difference
Pretest	9.83 (1.82)	0.00
Posttest	20.57 (1.22)	10.74

The findings of this study demonstrated a significant improvement in elementary school students' locomotor motor skills following the implementation of the Game-Based Athletics Activity Model. The mean score increased from 9.83 (SD = 1.82) at pretest to 20.57 (SD = 1.22) at posttest. The Wilcoxon signed-rank test further confirmed that all participants achieved higher posttest scores than pretest scores, as indicated by 30 positive ranks ($Z = -4.782$, $p < 0.001$). These findings provide empirical evidence that the Game-Based Athletics Activity Model is effective in enhancing the locomotor motor skills of elementary school students.

Discussion

The findings of this study demonstrated a significant improvement in students' he findings of this study showed an improvement in students' locomotor motor skills after using the Game-Based Athletics Activity Model. The average TGMD-3 locomotor score rose from 9.83 to 20.57 showing that locomotor performance got better after eight sessions. This change can be explained by the chances students had to practice running, jumping, turning and moving together inside five game-based activities. These games let students repeat locomotor

movement patterns in tasks. Earlier research says that game-based learning and gamification in education can make students more engaged and help them learn better (Camacho-Sánchez, 2023; Hasan et al., 2024). Game-based interventions also show effects, on children's motor skills (Camacho-Sánchez, 2023;Hasan et al., 2024), while game-based interventions have also demonstrated positive effects on children's motor skills (Muliadin et al., 2025) and systematically designed fundamental movement skill interventions can improve children's motor competence through developmentally appropriate and repeated movement experiences (Koolwijk et al., 2024;Yin et al., 2025).

The improvement can be better understood by looking at the movement demands in the five activities. Sprint Bendera Nusantara and Estafet Kilat Ceria gave students chances to run, accelerate and move their arms and legs together. This helped strengthen locomotor control. Reaksi Petir Sprint added reactions to sound and light cues so students had to start moving and shift from a standing position into a sprint. Lintasan Ninja Sprint made things more complex by mixing running with jumping, zig-zagging and avoiding obstacles. This required balance, agility, awareness of space and changing direction smoothly. Sprint Juara Mini let students practice running and starting skills in a game-like setting. All these activities matched the locomotor skills in the TGMD-3 especially running and jumping. The changes, in direction, balance and coordination added challenges that may have helped build locomotor ability(Apriyadi et al., 2026), who developed a game-based movement model that integrated running, jumping, and other fundamental movement skills through progressively structured games for elementary school students.

The repeated practice of these movement patterns within varied and meaningful game contexts may have facilitated motor learning by allowing students to repeatedly perform locomotor actions while adapting their movements to different task demands. This interpretation is consistent with evidence that structured and varied movement activities, including small-sided games and fundamental movement circuits, can enhance children's motor performance by providing diverse movement experiences and adaptive motor challenges (Priyambada et al., 2026). his view also matches research showing that game-based physical education can increase children's enjoyment and engagement.(Mo et al., 2024), At the time structured and progressive motor activities can offer repeated movement challenges that support the development of motor skills (Septaliza et al., 2026). Fundamental movement skills also serve as a base for physical literacy and for continued involvement, in physical activity (Piotrowski et al., 2025)**.** Therefore the improvements seen in this study may not be due to the use of games. The gains might come from the repetition and progressive changes in locomotor movements, within the Game-Based Athletics Activity Model.

Conclusions

This study shows that the Game-Based Athletics Activity Model really helps elementary school students improve their locomotor motor skills. When athletics is mixed with a range of game-based activities the model offers fun, interesting and age-appropriate learning opportunities that help students develop movement skills. The big differences found between the scores before and after the study show that the goal of improving students locomotor motor skills through the Game-Based Athletics Activity Model was reached successfully.

This study adds something to the area of physical education by giving real proof for a student-centered game-based way to teach athletics that helps students build basic movement skills. However the results need to be seen with some limitations in mind. These include using a one-group pretest- setup and having a small number of students. More research should use setups like randomized controlled or quasi-experimental designs. It should also include students, from different backgrounds and look at how well the model works in different school levels and settings to make the results more widely applicable.

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Conflict of interest

The authors declare that there are no conflicts of interest related to the conduct, analysis, or publication of this study. The research was conducted independently without any financial, commercial, or personal influence that could have affected the study design, data collection, data analysis, interpretation of the findings, or preparation of the manuscript.

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