HALAMAN OLAHRAGA NUSANTARA (HON)
Jurnal Ilmu Keolahragaan

Volume 9 No I
Tahun 2026

ISSN 2614-2775 (Print)
ISSN 2621-8143 (Online)

LOCOMOTOR MOTION GAME MODELS FOR KIDS EARLY AGE

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Abstract
The development of locomotor motion is a crucial foundation in the achievement of early childhood gross motor development which has a direct impact on their active participation in various physical and social activities. However, the learning approach in various early childhood education institutions (PAUD) is often unstructured and unattractive, thus hindering the optimization of the development of this aspect. This study aims to develop and test the effectiveness of a locomotor motion game model designed specifically for children aged 5-6 years. This model was developed using a Research and Development (R&D) approach by adapting the Borg & Gall model. The research procedure includes: (1) initial needs analysis, (2) model draft development, (3) expert validation (PAUD teachers and child motor experts), (4) limited field trials, and (5) final revision. The trial subjects involved 30 early childhood children in one of the Rawamangun kindergartens. Quantitative data on model effectiveness were collected through pre-test and post-test using the Test of Gross Motor Development-2 (TGMD-2) instrument and analyzed with a t-paired sample test. Qualitative data on the feasibility of the model were obtained through expert validation questionnaires and observation sheets. The results of the study showed that the game model developed was considered very feasible by experts with an average score of 4.5 out of a scale of 5. The results of the effectiveness test indicated a significant improvement in the child's locomotor movement ability ($p < 0.05$), with an average pre-test score of 38.2 and post-test of 51.7. The implication of this study is that a structured and fun activity-based game model can be an effective learning alternative for early childhood teachers in improving the development of early childhood locomotor movements.
Keywords: *Locomotor Motion; Early Childhood; Game Model; motor development; Physical Education*

Submitted : 02th of December 2025
Accepted : 31th of January 2026
Published : 31th of January 2026
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DOI http://dx.doi.org/10.31851/hon.v9i1.21229

INTRODUCTION

Early childhood, which includes the age range of 0 to 8 years, is the golden age in the course of human life. In this phase, various aspects of fundamental development including cognitive, affective, social-emotional, and psychomotor occur rapidly and are interrelated (UNICEF, 2019). Among these aspects, motor

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development occupies a central position because it is a prerequisite for children to explore the environment, interact with peers, and access various learning experiences (Gallahue, Ozmun, & Goodway, 2012). Motor development is generally divided into two main categories, namely gross motor and fine motor. Gross motor involves using large muscles to perform movements that involve the whole or most of the body, while fine motor focuses more on the coordination of small muscles such as hands and fingers (Haywood & Getchell, 2014).

One of the most fundamental components of gross motor is locomotor motion. Locomotor motion is defined as the movement that moves the body from one place to another in space (Pangrazi & Beighle, 2016). These abilities include a variety of basic movement patterns such as running, jumping, jumping, walking, and sliding. Good mastery of locomotor motion is not only important for physical fitness and health, but also has a positive correlation with a child's cognitive development, school readiness, and social competence (Piek, Dawson, Smith, & Gasson, 2008). Children who have good locomotor skills tend to be more confident, more active in play, and more receptive in their peer groups (Stodden et al., 2008). Conversely, delays or deficits in locomotor motion development can be a strong predictor of more serious problems later in life, such as obesity, low participation in physical activity, and mental health-related issues (Lubans, Morgan, Cliff, Barnett, & Okely, 2010).

Given the importance of this aspect, the provision of a learning environment that is able to stimulate and optimize the development of children's locomotor movements is a necessity, especially in the context of early childhood education (PAUD). Early childhood physical education should not only focus on physical development, but should also be designed to be fun, challenging, and meaningful for the child (Goodway, Robinson, & Crowe, 2010). One of the most effective learning media that suits the world of children is games. Through play, children learn naturally, are actively engaged, intrinsically motivated, and are able to express themselves freely (Pellegrini & Smith, 1998). Piaget (1962) argued that play is an expression of assimilation and accommodation, in which children build their

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understanding of the world through physical and social interactions. Vygotsky (1978) added that play, especially in the Proximal Developmental Zone (ZPD), allows children to operate at a higher cognitive and physical level than they achieve on their own.

Nonetheless, the reality on the ground often shows that there is a gap between theory and practice. Many PAUD teachers do not have an adequate understanding of how to design and implement structured and game-based locomotor movement learning (Hardman, Murphy, Lynne, & Clisby, 2015). Learning is often spontaneous, without a clear learning objective, or even ignored in favor of focusing on academic aspects such as reading, writing, and arithmetic (calistung). As a result, children's potential to develop their basic movement skills is not optimally exploited. Research in various countries, including Indonesia, shows that the level of basic movement mastery in early childhood is still concerning (Fjørtoft, Pedersen, Sigmundsson, & Vereijken, 2011; Novi, & Budiyanto, 2020).

This condition is exacerbated by the lack of relevant and easily accessible learning resources for teachers. Existing motion learning models or curricula are often too theoretical, uncontextual with local cultures, or require expensive equipment and are difficult to find in a school environment. Therefore, there is an urgent need to develop a learning model that is practical, effective, and attractive to early childhood. This model should be designed taking into account the principles of child development, the characteristics of fun play, and the resource limitations that teachers often face in the field.

This study seeks to answer these challenges by developing a "Locomotor Motion Game Model for Early Childhood". This model is designed not just as a collection of physical activities, but as a systematic learning framework, which includes learning objectives, a gradual sequence of activities, assessment methods, and guidelines for teachers. The model integrates various forms of play such as imitation games, simple games, and games with modular rules to target the development of six main components of locomotor motion: walking, running, jumping, jumping, sliding, and gliding.

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The conceptual framework of this study is based on three main theoretical pillars. First, the Theory of Motor Development from Gallahue et al. (2012) which maps the stages of movement development from the reflective stage to the maturity stage, which is a reference in determining the target age and difficulty level of the game. Second, the Motor Learning Theory from Schmidt and Lee (2014) which emphasizes the importance of variable practice and effective feedback to improve learning and retention of motor skills. In this model, the variety of games and scaffolding of the teacher plays a key role. Third, the Intrinsic Motivation Theory, especially the Self-Determination Theory (Deci & Ryan, 2000), which explains that the need for autonomy, competence, and relational attachment are the foundations of internal motivation. This game model is designed to meet all three needs through game choices, adjustable difficulty levels, and positive social interactions.

Based on the description above, this research was formulated with the main goal of developing a product in the form of a valid, practical, and effective locomotor motion game model to improve the locomotor movement ability of children aged 5-6 years. Specifically, the objectives of this study are: (1) To identify the needs of teachers and children's characteristics related to locomotor motion learning; (2) Develop a draft model of locomotor motion games based on the principles of child development and motor learning theory; (3) Testing the validity of experts on the developed model from the aspects of material, concept, and practicality; (4) Testing the effectiveness of the model in improving early childhood locomotor movement ability through field trials.

The significance of this research lies in its contribution to three main parties. For early childhood, this model provides a fun movement learning experience, which can improve physical ability, confidence, and long-term interest in physical activity. For early childhood teachers, this model is a practical guide that can be implemented directly in the classroom, helping them design more structured and meaningful physical learning. For the academic world and curriculum developers, this study provides empirical evidence on the effectiveness of the game-based

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approach and adds to the wealth of science in the field of early childhood physical education, especially in the Indonesian context.

METHODS

This research uses a Research and Development (R&D) approach that aims to produce a specific product and test the effectiveness of the product (Sugiyono, 2017). The development model used adapts the steps of the simplified Borg & Gall (1983) model into five main stages for time and resource efficiency, namely: (1) Research and Initial Information Gathering, (2) Initial Product Draft Planning and Development, (3) Expert Validation, (4) Limited Field Trials, and (5) Revision and Final Product.

Design and Research Subjects

The design of this study is a pre-experimental design with a type of one-group pre-test post-test design. This design is used to measure the effectiveness of the model developed by giving treatment to one group of subjects, then comparing scores before and after treatment (Creswell, 2012).

The research subjects in the field trial stage were 30 children aged 5-6 years (group B) from one of the Rawamangun Kindergartens (TK). The selection of subjects uses purposive sampling techniques with the consideration that the school has adequate facilities and good cooperation with researchers. In addition, the study also involved three expert validators, consisting of: (1) an expert lecturer in early childhood physical education, (2) a senior PAUD teacher practitioner with more than 10 years of experience, and (3) a child motor expert from the faculty of sports sciences.

Research Instruments

The instruments used in this study are designed to collect qualitative and quantitative data.

Expert Validation Questionnaire: The questionnaire is used to assess the feasibility of the developed model. This questionnaire was prepared in the form of a Likert scale of 1 (very poor) to 5 (very good) with several aspects of assessment, including: (a) Content/material feasibility (suitability with the child's developmental stage),

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(b) Construction feasibility (game structure, sequence, clarity), and (c) Language feasibility (readability, clarity of instructions).

Test of Gross Motor Development-2 (TGMD-2): This standard instrument is used to quantitatively measure a child's locomotor movement ability. TGMD-2 (Ulrich, 2000) has high validity and reliability and has been widely used in various international studies. The six locomotor subtests tested were: run, gallop, hop (jumping with one leg), leap (jumping with one foot far forward), horizontal jump (long jump), and slide (sliding the side leg).

Observation Sheet: Used to record qualitative data during the model implementation process, such as the level of child involvement, enthusiasm, difficulties faced, and interaction between teacher and child.

Research Procedure

The research procedure is carried out following the R&D stages that have been determined:

Stage 1: Research and Initial Information Gathering. The researcher conducted a literature study to build a theoretical framework and analyze the needs in the field through interviews with several PAUD teachers and direct observations in the classroom.

Stage 2: Initial Draft Planning and Development. Based on the results of phase 1, the researcher compiled an initial draft of the game model. This draft includes a teacher's handbook that contains the background, objectives, detailed descriptions of each game (game name, objectives, equipment, how to play, variety, and scoring points), as well as a simple scoring format.

Stage 3: Expert Validation. The initial draft of the model and its assessment instruments were sent to three expert validators. They were asked to provide assessments and inputs through a validation questionnaire. The results of the validators are analyzed to determine their validity index. A product is said to be valid if the average total score of all validators is at least 3.5 (good to excellent category).

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Stage 4: Limited field trials. After being revised based on validator input, the model was piloted on 30 children for 8 weeks with a frequency of 2 times a week, a duration of 30 minutes per session. Before the implementation (first session), all children were given a pre-test using TGMD-2. After 8 weeks of implementation, the child is given a post-test with the same instrument.

Stage 5: Revision and Final Product. Based on the test results (both quantitative and qualitative from the observation sheet), the model was revised again for refinement before being produced as a final product.

Data Analysis

The data obtained were analyzed using two approaches:

Qualitative Data: Data from the expert validation questionnaire were analyzed descriptively by calculating the average score for each aspect. Data from the observation sheets were analyzed thematically to identify patterns that emerged during implementation.

Quantitative Data: Pre-test and post-test data from TGMD-2 were statistically analyzed. Data normality tests were performed using Shapiro-Wilk. Since the sample count > 30, the assumption of normality is acceptable. To test the hypothesis of a significant increase, a t-paired sample test is used. All statistical analyses were carried out with the help of the Statistical Package for the Social Sciences (SPSS) software version 25.0 with a significance level of $\alpha = 0.05$.

RESULTS

This research has produced a product in the form of a locomotor motion game model for early childhood. The results of the research are presented based on the stages carried out, namely the results of expert validation and the results of the model effectiveness trial.

Expert Validation Results

Validation was carried out to determine the feasibility level of the game model from the material, construction, and linguistic aspects. Three experts gave an assessment of the draft model developed. A summary of the results of expert validation is presented in Table 1.

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Table 1. Results of Expert Validation of Locomotor Motion Game Model

Aspects Assessed	Average Score (Scale 1-5)	Categories
Content/Material Eligibility	4,60	Excellent
Feasibility of Construction	4,45	Excellent
Language Qualifications	4,50	Excellent
Overall Average	4,52	Excellent

Based on Table 1, it can be seen that the developed game model obtained an overall average rating of 4.52, which falls into the category of "Excellent". The feasibility aspect of content/material received the highest score (4.60), showing that the material and concept of locomotor motion presented were very appropriate for the developmental stage of children aged 5-6 years. The validator gave positive feedback that the order of the game from the simplest to the most complex had been systematically arranged. The construction and language aspects also scored highly, indicating that this model is easy for teachers to understand and implement in the field. Some minor revision inputs from validators, such as the addition of image illustrations and simplification of technical terms, have been made before the field trial stage.

Model Effectiveness Test Results

An effectiveness test was conducted to find out if there was a significant improvement in the child's locomotor movement ability after being treated using the developed game model. Pre-test and post-test data were analyzed using a t-test paired sample.

Table 2. Descriptive Results of Pre-test and Post-test Scores of Locomotor Movement Ability (N=30)

Statistics	Pre-test	Post-test
Red	38,20	51,70
Standard Deviation	5,45	4,12
Minimum Score	28	44
Maximum Score	48	60

Table 2 shows an increase in the average score of locomotor movement ability from 38.20 in the pre-test to 51.70 in the post-test. The standard deviation also decreased, indicating that the spread of scores between subjects became more homogeneous after treatment, meaning that most children experienced a similar improvement.

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To test the significance of the increase, a t-paired sample test was performed. The results of the statistical test are presented in Table 3.

Table 3. Paired Sample t-test results on Pre-test and Post-test scores

Paired Differences	t	df	Sig. (2-tailed)
Red	Std. Deviation		
-13,50	4,85	-15,258	29

The results of the analysis of the t-paired sample (Table 3) showed that the calculated t-value was -15.258 with a significance value (p) = 0.000. Because the p< value is 0.05, the null hypothesis (H0) stating that there is no significant difference between pre-test and post-test scores is rejected. Thus, it can be concluded that there is a significant improvement in early childhood locomotor movement ability after participating in learning using the developed game model.

Implementation Observation Results

Qualitative data from the observation sheet showed that the implementation of the model was going well. Children's attendance and participation rates are very high (average 95%). The children showed great enthusiasm, as seen in their laughter, happy expressions, and liveliness in following every instruction. The implementing teacher also reported that the model was easy to follow and the guidance provided was helpful. Some minor challenges that arise, such as children's difficulties in understanding the rules of the game that are too complex, can be overcome with modifications and simpler explanations from the teacher.

DISCUSSION

This study succeeded in developing a model of locomotor motion games for early childhood that was proven to be valid and effective. The main finding of this study is that there is a significant improvement in locomotor movement ability in early childhood after being given an intervention using the developed model. These results are in line with the main goal of the research and make an important empirical contribution to the world of early childhood physical education.

Effectiveness of Game Models Based on Motor Learning Principles

The significant improvement seen from the results of the t-test ($p < 0.05$) confirms that the developed game model is effective in improving locomotor

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movement ability. This effectiveness can be explained through the lens of motor learning theory. First, this model applies the principle of variable practice. As expressed by Schmidt and Lee (2014), practices with meaningful variations are more effective for the formation of motor schemas than repetitive and monotonous practices. In this model, one basic movement pattern (e.g., jumping) is practiced through different types of games with different rules and challenges. For example, a child jumps to jump over a "river" (rope), jumps to catch a "cloud ball" (balloon), or jumps on a "frog" (foam). This variation forces the child to constantly adapt, process new sensory information, and adjust their movement patterns, which ultimately strengthens the understanding and flexibility of those skills.

Second, this model integrates timely and constructive feedback. In each session, the teacher not only acts as a facilitator but also as an observer who provides feedback. The feedback given is positive and specific, for example "Good, Ani! The jump is so high!" or "Try swinging your hands harder when you run!". According to Wulf, Shea, & Lewthwaite (2010), positive feedback can increase self-efficacy and motivation of children, which in turn optimizes motor learning. Meanwhile, specific feedback helps the child understand which aspects of their movements need improvement.

Third, the structure of the model that ranges from simple to complex is in line with the scaffolding concept of Vygotsky (1978). Each game is designed to be within the child's Proximal Development Zone (ZPD), which is a level of difficulty that is slightly above their current ability, but can still be achieved with the help of a teacher or friend. When the child has mastered a level, the teacher can introduce more difficult variations or rules, thus continuing to challenge the child to develop without frustrating them. This approach ensures that the child continues to feel competent and motivated to learn.

The Role of Games in Increasing Intrinsic Motivation

The success of this model lies not only in the technical aspects of motor learning, but also in its ability to awaken the child's intrinsic motivation. The results of the observations showed a very high level of enthusiasm and excitement of the

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children during learning. This phenomenon can be explained using the Self-Determination Theory (SDT) proposed by Deci and Ryan (2000). SDT states that intrinsic motivation will develop rapidly when three basic psychological needs are met: autonomy, competence, and relatability.

This game model implicitly meets all three needs. The need for autonomy is met by giving children choice in several activities. For example, in the game "Garden Animals", the child can choose to be the "jumping rabbit" or the "running horse". Choices, while simple, give children a sense of control over their actions. The need for competence is met through tiered game design. Children experience repeated success when they are able to complete challenges in the game. Each success reinforces their perception of being capable individuals, which is a powerful motivator. The need for relational attachment is met because most games are designed to be played in groups. Children interact, cooperate, and support each other with their peers, creating a positive and fun social environment.

These findings are in line with previous studies that show that play-based approaches are superior in increasing children's motivation and participation compared to traditional drill approaches (Sallis, Prochaska, & Taylor, 2000; Jago, Baranowski, Thompson, & Baranowski, 2009). When children are intrinsically motivated, they tend to be more resilient in the face of adversity, more creative, and more likely to maintain the habit of active movement in the long term (Ryan & Deci, 2000).

Practical Implications for Early Childhood Education Teachers

The results of this study have significant practical implications for early childhood education teachers. The developed model offers solutions to some of the challenges that teachers often face, such as lack of time to plan physical learning and limited knowledge about motor movements. The teacher guide included in this model provides a ready-to-use framework, complete with game descriptions, learning objectives, and simple grading methods. This can reduce the administrative burden on teachers and give them the confidence to teach movements.

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Furthermore, this study emphasizes the importance of the role of teachers as creative and responsive facilitators. The teacher is no longer a rigid instructional, but a player, motivator, and intelligent observer. Using this model, teachers are trained to be more sensitive to children's responses, ready to modify games according to needs in the field, and able to create a safe, fun, and challenging learning environment. The implication is a paradigm shift in early childhood learning from being "activity-oriented" to "learning experience-oriented" which is meaningful.

Research Limitations and Future Research Directions

Although the results are promising, the study has some limitations that need to be acknowledged. First, the sample of the study used was relatively small (N=30) and came from a single school in an urban area, so the results may not be broadly generalized to the entire early childhood population in Indonesia, especially those in rural areas or with different characteristics. Second, the duration of the 8-week intervention may not be sufficient to measure long-term skills retention. The study only measured the impact immediately after the intervention ended.

Based on these limitations, several directions for future research can be offered. Further research is recommended to use a quasi-experimental design with a control group to strengthen the evidence of causality and compare the effectiveness of this model with other approaches. In addition, studies with a larger, more diverse (multi-site) sample are needed to improve the generalization of results. Longitudinal research is also important to conduct to look at the long-term impact of these interventions on physical development, physical activity motivation, and even children's health later in life. Finally, research can also focus on developing similar models for other aspects of motor development, such as manipulative motion (throwing, catching, kicking) or balance.

CONCLUSION

Based on the results of the research and discussion that has been presented, it can be concluded that: (1) The locomotor motion game model for early childhood has been successfully developed by adapting the Borg & Gall R&D model. This

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model is considered very feasible by experts with an average score of 4.52. (2) The developed game model was significantly effective in improving the locomotor movement ability of children aged 5-6 years, which was shown by an increase in the average score from 38.20 to 51.70 ($p < 0.05$). (3) The effectiveness of this model is supported by the application of the principles of motor learning (variable practice, feedback, and scaffolding) and its ability to meet the basic psychological needs of children (autonomy, competence, and relational attachment) which have an impact on increasing intrinsic motivation.

This game model is recommended to be adopted and implemented by early childhood education teachers as an alternative to physical learning that is structured, fun, and effective. Thus, it is hoped that it can help create a generation of children who are not only cognitively intelligent, but also have a strong motor foundation for a more active and healthy life.

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