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Project Based Learning Based on Basic Locomotor Movement Skills in Physical Education Learning

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Abstract

Study purpose. This study aims to develop a Project Based Learning (PBL) model based on basic locomotor movement skills and evaluate its effectiveness in learning Physical Education in elementary schools.

Materials and methods. The research method uses a Research and Development (R&D) approach with the ADDIE model, which includes analysis, design, development, implementation, and evaluation. The research subjects were students of PUBLIC PRIMARY SCHOOL 11 Bima Citywith an initial test involving 20 students and a final test involving 40 students. The measurement instrument for basic locomotor movement skills used the Test of Gross Motor Development (TGMD), including running, jumping, and hopping skills. Data were collected through observation, interviews, and tests, then analyzed qualitatively and quantitatively using the t-test, N-Gain, and Aiken's V validation.

Results. The results of the study showed a significant increase in students' abilities after the implementation of the model. The average pretest score (cognitive 66.5; affective 66.8; psychomotor 68.0) increased in the posttest (cognitive 85.3; affective 86.0; psychomotor 88.5). The t-test obtained a value of 30.51 with p = 0.000 (<0.05), N-Gain of 58.18% was in the medium to high category, and Aiken's V validation showed very valid criteria (0.89–0.94).

Conclusion: The findings show that integrating TGMD into the PBL framework effectively improves locomotor skills, active participation, motivation, and collaboration, thereby supporting holistic development and enhancing the quality of physical education learning.

Keywords: Project based learning, locomotor, physical education, TGMD.

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Introduction

The development of 21st-century education demands a transformation in the learning process to foster students' creativity, collaboration, and critical thinking skills. In this context, teachers are required not only to deliver material but also to create meaningful, active, and student-centered learning experiences (Estrada Oliver et al., 2020). However, the reality on the ground shows that physical education learning still tends to be conventional and dominated by the role of the teacher, thus providing little space for students to explore their potential (Lubis, 2021). As a result, basic locomotor movement skills, which should be the foundation of children's motor development, have not developed optimally. In fact, basic movement skills such as running, jumping, and leaping play a crucial role not only in physical aspects but also in supporting students' cognitive, affective, and socio-emotional development (Abdullah & Nurrochmah, 2021). Basic movement material makes learning more enjoyable, can stimulate intellectual, emotional, spiritual, and even collective intelligence (Yudaparmita, 2022).

Efforts to improve fundamental motor skills are inseparable from a learning approach that is tailored to the child's characteristics. Project-Based Learning (PBL) is an innovative learning model proven to encourage students to learn actively, collaboratively, and contextually (Simonton et al., 2021). Project-based learning (PBL) is an innovative teaching methodology that uses learning activities to engage students' interest and motivation (Almazroui, 2023). PjBL has been shown to improve motor skills in sports such as dribbling (Hardinata et al., 2023) and underhand passing (Raaiyatini et al., 2024). However, its application to basic locomotor movements is still limited, necessitating the development of a more measurable PjBL model tailored to student needs. Through authentically designed projects, students not only practice physical movements but also learn to solve problems, communicate ideas, and collaborate in groups. Several studies have reported that the application of PBL in physical education can increase students' learning motivation, creativity, and positive attitudes toward physical activity (Mahendra et al., 2023). Almost all students expressed their belief that project-based learning was very engaging (Maros et al., 2023). However, most of these studies still emphasize the enjoyable aspects of the learning experience, without specifically integrating measurable instruments to evaluate the development of students' locomotor skills.

One instrument that can be used to comprehensively measure motor skills is *the Test of Gross Motor Development* (TGMD). This instrument assesses locomotor skills such as running, jumping, hopping, and sideways movements, thus providing an objective picture of students' motor abilities (Sari et al., 2019). Fundamental movements are the foundation of human behavior and help children learn new skills in other areas (Sukoco et al., 2024). The integration of PBL with TGMD has the potential to create a comprehensive learning experience, where learning projects not only improve motor skills but also foster an understanding of movement concepts (cognitive) and shape students' positive attitudes toward physical activity (affective). The positive correlation between physical activity and student creativity also confirms that learning that combines motor activities with project-based strategies can strengthen students' intellectual, emotional, and social intelligence (Piya-Amornphan et al., 2020). Thus, this approach aligns with the goal of physical education, which is to develop students' full potential (Richard et al., 2021).

Observations at Public primary school 11 Bima Cityrevealed that physical education learning remains conventional and teacher-centered, providing limited opportunities for students to explore and develop their creativity. The learning activities tend to be repetitive, lack contextual relevance, and fail to integrate cognitive and affective aspects into the learning process (Lubis, 2021). Fundamental motor skills such as running, jumping, and hopping have also not developed optimally due to the absence of standardized instruments to objectively assess students' abilities (Abdullah & Nurrochmah, 2021). Furthermore, students' motivation and participation remain low because of the limited variety of activities and the lack of active

involvement in the learning process (Utami et al., 2022). This condition highlights a gap between classroom practices and the demands of 21st-century education, which emphasize creativity, collaboration, and critical thinking (Estrada Oliver et al., 2020).

Previous studies have shown that the Project-Based Learning (PBL) model is effective in enhancing creativity, motivation, and positive attitudes toward physical activity (Juliantine et al., 2020) and (Mahendra et al., 2023). However, most of these studies have not integrated the objective assessment of fundamental movement skills using the Test of Gross Motor Development (TGMD) instrument. Conversely, research on TGMD has primarily focused on assessing motor abilities without linking them to innovative learning approaches such as PBL (Sari et al., 2019) and (Sukoco et al., 2024). This gap underscores the urgency of developing a TGMD-based PBL model that can holistically improve students' abilities across cognitive, affective, and psychomotor domains. Therefore, this study at PUBLIC PRIMARY SCHOOL 11 Bima aims to provide both theoretical and practical contributions to the development of more meaningful, measurable, and student-centered physical education learning

Materials and Methods

Study participants

This research was conducted at Elementary School 11 in Bima City, involving several groups of participants. First, two academics from the field of physical education served as expert validators, assessing the feasibility of the Project Based Learning (PBL) model design based on basic locomotor movement skills. They provided conceptual and methodological input, particularly regarding the suitability of the material to theories of child motor development. Second, two classroom teachers played a crucial role in the implementation of the model in the field. Teachers acted as both facilitators and implementers of learning, so the model's success depended not only on the design but also on their skills in integrating PBL into real-life classroom contexts. Third, a student sample served as the primary test subjects. A pretest was conducted on 20 students to identify basic locomotor skills, while a posttest was conducted on 40 students to evaluate the model's effectiveness. The student sample was selected using purposive sampling, a non-probability sampling technique chosen to ensure that participants met specific criteria relevant to the research objectives. The inclusion criteria included (1) being enrolled in grades 4–5, (2) having normal physical and health conditions for participation in physical activities, and (3) attending at least 80% of physical education classes during the research period. This technique was chosen to ensure that the participants represented the target population with sufficient motor development maturity to engage in locomotor skill activities.

This type of research was Research and Development (R&D) using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). This methodology was chosen based on the need to produce a valid, practical, and effective learning model. However, during the implementation phase, the research design adopted a quasi-experimental approach with a pretest–posttest design. The rationale for using this design was to objectively measure the effect of implementing the TGMD-based PBL model on improving students' fundamental motor skills. The pretest was used to determine students' initial abilities, while the posttest measured significant changes after treatment.

During the implementation phase, the research design adopted a quasi-experimental approach with a pretest–posttest pattern to connect the development and evaluation stages of the ADDIE model. This design ensured that the developed product, the TGMD-based PBL model, could be empirically examined for its effectiveness after passing validation and practicality tests. The quasi-experimental method was chosen because it enables the examination of causal relationships between the implementation of the learning model and the improvement of students' basic locomotor movement skills, even when random participant

assignment is impractical due to real classroom constraints (Simonton et al., 2021). The rationale for employing this design lies in its ability to objectively measure changes in students' learning outcomes while maintaining ecological validity within authentic school environments. The pretest was administered to establish baseline motor skill levels, while the posttest measured subsequent improvements after the intervention. Data were analyzed using the t-test and N-Gain to assess the significance and magnitude of learning gains, as these techniques are commonly applied to evaluate instructional effectiveness in educational research. Overall, this quasi-experimental phase served as a confirmatory validation, demonstrating that the TGMD-based PBL model was not only theoretically sound and practically feasible but also empirically effective when implemented in the real-world classroom context.

Study organization

This study organized the data collection process through a combination of interviews, observations, questionnaires, and motor skills tests using the Test of Gross Motor Development (TGMD). In-depth interviews were conducted with two academics as expert validators and two classroom teachers as practitioners, each lasting approximately 30–45 minutes, aimed at exploring perceptions, challenges, and potential for implementing the Project Based Learning (PBL) model based on locomotor skills. Observations were carried out systematically at both the class and individual levels, with each student observed at least twice to ensure skill development could be accurately mapped. In addition, a 20-item questionnaire based on a Likert scale (1–5) was used to measure student motivation, engagement, and satisfaction with the learning process (Stefaniak & Xu, 2020). The Test of Gross Motor Development (TGMD) instrument was used to assess seven fundamental locomotor skills that reflect children's overall motor proficiency. First, running evaluates the ability to move quickly and rhythmically with coordinated arm and leg movements. Second, galloping measures the ability to travel forward using a repetitive step–together pattern, with one foot consistently leading. Third, hopping assesses balance and leg strength as the child repeatedly hops on one foot while maintaining stability. Fourth, horizontal jumping observes the ability to jump forward using both feet simultaneously and land with proper balance. Fifth, leaping measures the ability to propel the body forward from one foot and land on the opposite foot in a smooth, extended motion. Sixth, skipping evaluates coordination and rhythm through an alternating pattern of step and hop on each foot. Lastly, sliding assesses the ability to move sideways with a smooth step-together motion while maintaining body alignment and lateral balance. Each skill was performed twice, with performance evaluated based on indicators such as fluidity, balance, coordination, and body control according to TGMD guidelines (Sari et al., 2019). Each skill was given two attempts, with passing criteria determined based on movement indicators in accordance with TGMD guidelines. To support the learning process, teaching materials were prepared in the form of educational cards containing movement project instructions, collaborative games that emphasize locomotor creativity, and simple equipment such as balls, cones, and mats. The practical procedure was designed in eight meetings, with each session lasting 60 minutes, consisting of a warm-up, project exploration, game activities, and a final reflection to strengthen the students' learning experience. This research took place over three months at Elementary School 11 in Bima City, covering the stages of needs analysis, design, development, implementation, and final evaluation. Before being applied to students, the TGMD based PBL model design was validated by two physical education experts to ensure the suitability of the content and procedures, then tested on a limited basis, so that the instruments and methods used truly met the scientific and practical criteria for application in physical education learning. Analysis: analyzing the needs, characteristics of students, and conditions of physical education learning. Design: designing a PBL model based on basic locomotor movement skills. Development: developing the initial product of the model and learning tools. Implementation:

testing the model on elementary school students. Evaluation: Evaluate the effectiveness of the model through validation tests and field trials. Data collection instruments include interviews, observations, and questionnaires distributed to different samples using Google Forms.

Statistical analysis

Statistical analysis is a crucial aspect of this research because it serves to objectively test the effectiveness of the Project Based Learning (PBL) learning model based on basic locomotor skills. The statistical significance level is set at $p < 0.05$ according to the general rules of quantitative research. Qualitative Analysis: conducted on observation and interview data to describe the process of model development and implementation. Quantitative Analysis: Expert validation through t-test, N-Gain, and Aiken's V to measure the level of product validity. Effectiveness test: conducted by comparing basic movement skill scores (pretest and posttest) to see the improvement in students' abilities after the application of the model, which means if the p-value is less than 0.05, there is a significant difference between the pretest and posttest results. Paired t-test is used to measure the significance of the increase in the average student score before and after treatment, while the N-Gain calculation is used to evaluate the effectiveness of the increase in the low, medium, or high categories (Sukarelawan et al., 2024). In addition, the validity of the instrument is evaluated with Aiken's V to ensure that the instrument used is truly valid for measuring locomotor skills (Aiken, 1980).

Results

To measure the effectiveness of the locomotor skills-based PjBL model, a pretest and posttest were conducted on 40 students. The average scores are presented in Table 1.

Table 1. Comparison of Pretest and Posttest Values

Aspect	Pretest (M ± SD)	Posttest (M ± SD)	Improvement	t-count	p-value
Cognitive	66.5 ± SD	85.3 ± SD	18.8	28.46	0,000
Affective	66.8 ± SD	86.0 ± SD	19.2	29.87	0,000
Psychomotor	68.0 ± SD	88.5 ± SD	20.5	31.22	0,000

*significance level 0.05

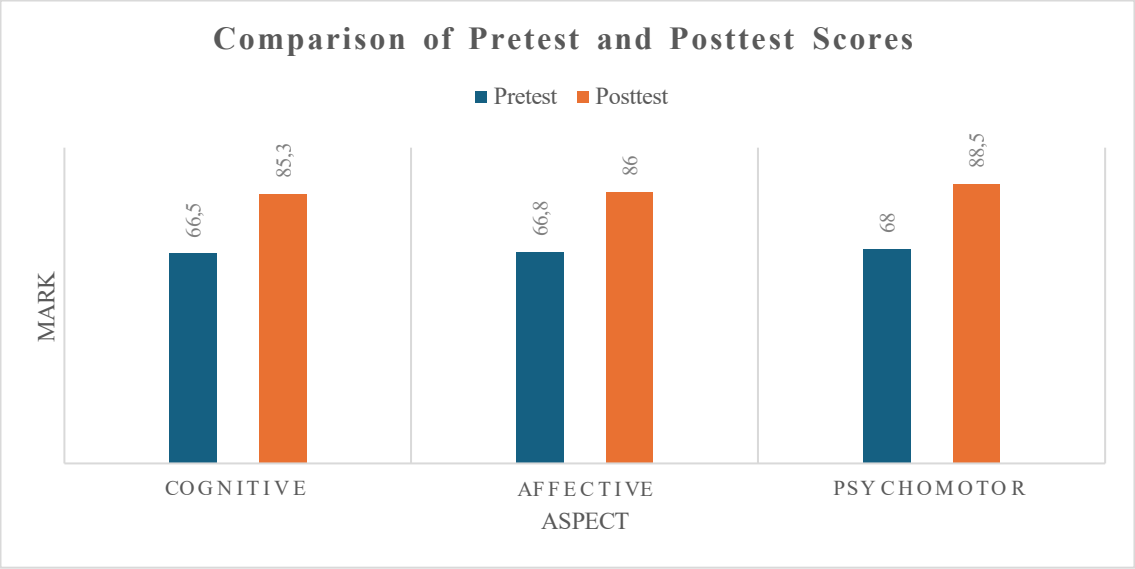

Figure 1. Comparison of Pretest and Posttest Scores

The results of the study showed a significant increase in cognitive, affective, and psychomotor abilities after the implementation of the Test of Gross Motor Development

(TGMD) method. A paired t-test showed a significant difference between the pretest and posttest at a confidence level of 0.05, thus concluding that learning with TGMD had a positive effect on student learning outcomes. The N-Gain calculation strengthened this finding by showing a high level of improvement, indicating that this method not only provided a temporary effect but also substantially improved the quality of understanding and skills. Validation using Aiken's V ensured that the instrument used had excellent validity, so that the measurement results were reliable Presented in Table 2. Thus, TGMD proved effective as a motor learning approach that was able to develop aspects of knowledge, attitudes, and motor skills in a balanced manner. The application of this method can be recommended in physical education learning to support the holistic development of students.

Table 2. Results of t-Test, N-Gain, and Validation

Statistics	Mark
Pretest Average	66.34
Posttest Average	85.93
t-statistic	31.22
p-value	0,000
N-Gain (%)	58.18
*significance level 0.05	

Table 3. Validation of Aiken's V by Experts

Aspect	Aiken's V
Cognitive	0.89
Affective	0.91
Psychomotor	0.94

Based on data in Table 3 the t-test results showed a t-statistical value of 31.22 with a p-value of 0.000, which is smaller than 0.005. This indicates that the difference between the pretest and posttest results is very significant. In other words, the implementation of the TGMD-based PBL model has a positive influence on improving student abilities. In addition, the N-Gain calculation result of 58.18 is in the moderate to high category, indicating that the improvement that occurred is not only statistically significant but also has a practically meaningful impact on learning. To ensure the validity of the instrument, Aiken's V validation was conducted by experts. The validation results showed a value of 0.89 for the cognitive domain, 0.90 for the affective domain, and 0.94 for the psychomotor domain, all of which are included in the very valid category. This means that the instrument used is appropriate and feasible to measure the effectiveness of the learning model.

Discussion

The findings of this study indicate significant improvements in three key domains cognitive, affective, and psychomotor after implementing a Project-Based Learning (PBL) model based on fundamental locomotor skills. Improvements in the cognitive domain are reflected in students' better understanding of basic movement principles and techniques, while the affective domain demonstrates higher motivation and more positive attitudes toward physical activity. In the psychomotor domain, students showed enhanced movement coordination, improved locomotor skills, and increased self-confidence in performing physical activities. These results reinforce previous findings that PBL can enhance students' critical thinking skills, motivation, and collaboration through project-based learning experiences (Simonton et al., 2021). School-based interventions (learning models, games, or modified

media) are effective in improving locomotor skills and often improve physical education learning outcomes (Yin et al., 2025).

The use of the Test of Gross Motor Development (TGMD) provided quantitative evidence that improvements in students' locomotor skills were statistically significant. The t-test and N-Gain analysis confirmed that the intervention through the TGMD-based PBL model had a strong and practically meaningful effect. These results are consistent with the studies by (Kain et al., 2018) and (Martínez & Abelairas-, 2025), which emphasized the importance of intensifying locomotor activities to improve the motor skills of school-aged children. Furthermore, this study aligns with the view of (Yolcu et al., 2024) that movement-based activities can develop students' problem-solving skills, creativity, and divergent thinking. Thus, the consistency of this study's results supports a holistic approach that integrates cognitive, affective, and psychomotor dimensions as an inseparable whole in the learning process.

The main novelty of this study lies in integrating the PBL model with the TGMD instrument to evaluate the effectiveness of learning based on fundamental locomotor skills. Most previous studies have focused only on enjoyable learning experiences or increased student motivation in project-based learning (Maros et al., 2023) and (Mahendra et al., 2023). However, this study fills the gap by introducing a standardized measurement tool that allows for an objective evaluation of basic motor skills. The measurable quantitative approach provides teachers and researchers with more reliable data to assess the effectiveness of learning models. Theoretically, this study expands the understanding of how project-based activities can improve motor skills while also supporting students' cognitive and affective development. In the context of physical education, this approach aligns with the concept of 21st-century education, which emphasizes the integration of critical thinking, creativity, collaboration, and communication skills (Estrada Oliver et al., 2020). Thus, PBL has proven effective not only in academic contexts but also in movement-based learning that emphasizes motor skill development.

This study also contributes to the discourse on student creativity in physical education. By increasing the intensity of physical activity through projects, students not only refine their locomotor skills but also develop creativity dimensions such as originality, elaboration, fluency, and flexibility (Romance et al., 2023). These findings align with a study (Juliantine et al., 2020), which confirmed that the PBL model can develop student creativity in physical education. The integration of TGMD within the PBL framework provides methodological novelty, as few studies have directly used this instrument to assess the success of learning models. Instrument validation using Aiken's V (0.89–0.94) strengthens the reliability of this approach, making it a useful reference for future studies seeking to evaluate innovative project-based learning in physical education more comprehensively.

The results of this study also provide important practical implications for physical education teachers and policymakers. For teachers, the TGMD-based PBL model can serve as an effective alternative learning strategy to improve students' fundamental movement skills through authentic projects emphasizing locomotor activities such as running, jumping, or hopping while integrating cognitive and affective learning goals. For schools, the findings highlight the importance of providing adequate facilities to support project-based learning implementation and fostering cross-subject collaboration among teachers to create more contextual and enjoyable learning experiences (Utami et al., 2022). For policymakers, this study provides empirical evidence that a locomotor skill-based PBL approach significantly improves the quality of physical education and aligns with the Pancasila Student Profile and the 21st-century education (Almazroui, 2023). This aligns with a study (Neville & Makopoulou, 2020), which confirmed that movement-based physical activity can be a means to enhance the creativity of school-age children. Overall, the TGMD-based PBL model not only enhances motor skills but also contributes to the development of non-physical aspects essential for students' holistic growth. However, several factors such as small sample size, variations in

teacher abilities, and the novelty of the method may influence the results. Therefore, further research with a more robust quasi-experimental design is needed to test the consistency of the findings. Overall, TGMD-based PBL has proven effective in developing students holistically and is an innovative approach to physical education learning in Indonesia.

Conclusions

The TGMD-based Project-Based Learning (PBL) model has proven effective in improving students' cognitive, affective, and psychomotor abilities. Students demonstrated better understanding of movement concepts, increased motivation, and improved coordination through authentic and collaborative projects. This integration supports holistic development and makes physical education learning more meaningful and measurable. Teachers are encouraged to apply PBL combined with TGMD to design engaging and student-centered learning activities. Schools should provide adequate facilities and promote collaboration among teachers. Educational institutions and policymakers are advised to adopt this model to strengthen the quality of physical education in line with 21st-century competencies.

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Conflict of interest

This research contains no conflicts of interest

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