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Application of the Biomechanical Approach in Learning Basic Long Jump Techniques for Students of Tamannyeleng Elementary School

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Abstract. This study aims to analyze the effect of the application of a biomechanical approach on improving basic long jump technical skills in elementary school students. The biomechanical approach is used to help students understand the principles of efficient body movement based on the laws of force, speed, and angle of push. This study used a quasi-experimental method with a One Group Pretest–Posttest Design implemented at SD Inpres Tamannyeleng, Gowa Regency. The research sample consisted of 30 fifth-grade students (15 boys and 15 girls) who participated in six meetings, including pretest, learning implementation, and posttest. The research instruments included long jump skill observation sheets, motion video recordings, and field notes that were analyzed quantitatively and qualitatively. The results showed a significant increase in basic long jump technical skills after the application of the biomechanical approach. The average student score increased from 64.23 in the pretest to 78.90 in the posttest, with a difference of 14.67 points or 22.8%. The Paired Sample t-Test produced a t value = 9.214 and Sig. (2-tailed) = 0.000 ($p < 0.05$), which shows that the application of the biomechanical approach has a real effect on improving students' skills. Qualitatively, there was improvement in coordination, balance, and movement efficiency in each phase of the long jump—from the run-up to the landing. It can be concluded that the biomechanical approach is effective in physical education learning in elementary schools because it not only improves students' technical abilities but also fosters a scientific understanding of body movement and the simple application of biomechanical principles.

Keywords: Biomechanical Approach, Physical Education, Long Jump, Basic Movement Skills.

1 Introduction

The long jump is a branch of athletics that requires the ability to combine strength, speed, coordination, and timing in a series of movements. The main goal of the long jump is to achieve the greatest possible distance from the takeoff point to the landing area (Hasanuddin, 2020). This movement does not only depend on the strength of the leg muscles, but also on mastery of technique and efficiency of body movements. According (Ardiansyah et al., 2024), good long jump performance depends on efficient body mechanics in generating optimal

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horizontal and vertical thrust. This means that the better the coordination and technique, the more effective the jump will be.

Physical education is an integral part of the education system which plays an important role in developing the physical, psychomotor, cognitive and affective potential of students through movement activities (Nurulita et al., 2023). Through the long jump, students learn to integrate muscle strength, speed, coordination, and balance into a single movement. This activity indirectly trains students' critical and reflective thinking skills, as they learn to understand the relationship between body position, propulsion, and the resulting jump.

In practice, many students experience difficulties during the takeoff and landing phases. This is often due to a lack of understanding of basic biomechanical principles, such as how the ideal takeoff angle affects jump distance, or how the position of the center of gravity affects balance while floating in the air. This is where the biomechanical approach plays a crucial role in the physical education learning process. This approach helps teachers explain why and how a movement is performed efficiently based on the laws of human physics.

Biomechanics is a branch of science that studies the forces and movements of the human body in physical activity and sports (Ardiansyah et al., 2024). According (Gilardino R et al., 2025) biomechanics provides a scientific foundation for understanding how external forces (such as gravity and ground reaction forces) and internal forces (muscle contractions) affect human motor performance. In the context of long jump learning, a biomechanical approach helps students understand basic principles such as: Run-up speed: the higher the horizontal speed before takeoff, the greater the momentum generated to achieve maximum jump distance. Take-off angle: determines the conversion of horizontal to vertical speed; the optimal angle ranges from 18°–22°. Arm Movement and Swing Coordination: helps increase propulsion and maintain body balance during the flight phase. Landing Position: determines body stability and jump efficiency.

The biomechanical approach aligns with the learning direction of the Independent Curriculum, which emphasizes a scientific approach (observing, asking, trying, reasoning, and communicating). In this context, sports learning is no longer merely practical, but also a means of developing scientific literacy through direct experience. By using the biomechanical approach, students are encouraged to: Observe the differences between efficient and inefficient movements. Conduct small experiments with varying takeoff angles and speeds. Draw conclusions about effective body movements based on the results of these observations.

The biomechanical approach provides a new perspective on long jump instruction in elementary schools. By integrating scientific principles into practical activities, students not only learn to move but also understand the scientific basis of each movement. This research is expected to provide empirical evidence that the application of a biomechanical approach can significantly improve basic long jump technical skills while strengthening scientific literacy in physical education.

2 Method

This study used a quasi-experimental method with a One Group Pretest–Posttest Design. This design was chosen because the study was conducted in existing classroom conditions without a control group, but still allowed researchers to compare students' abilities before and after being given treatment in the form of learning using a biomechanical approach. Through this design, changes in learning outcomes that occur after treatment can be observed directly to

determine the effect of applying a biomechanical approach on improving basic long jump technical skills. This research was conducted at Tamannyeleng Elementary School, Gowa Regency, over three weeks with a total of six meetings: one pretest, four biomechanical learning sessions, and one posttest. All activities were conducted during Physical Education (PJOK) classes under the guidance of the PJOK teacher and the researcher.

The population in this study were all fifth-grade students of SD Inpres Tamannyeleng who were participating in Physical Education. From the population, 30 students (15 boys and 15 girls) were selected as research samples using a purposive sampling technique. The sample selection was carried out by considering that the students had received previous athletics material, had a healthy physical condition, and were willing to participate in the entire series of research. This study consisted of two variables, namely the independent variable and the dependent variable. The independent variable in this study was the application of the biomechanical approach, namely a learning approach that emphasizes the understanding of the principles of body mechanics such as force, angle, and speed of movement to increase the efficiency of the long jump movement. Meanwhile, the dependent variable was the basic technical skills of the long jump, which include four main phases, namely the start, push, hover, and landing phase.

To obtain valid and reliable data, this study used several data collection instruments, including long jump technique observation sheets, motion video recordings, and field notes. The observation sheets were used to assess students' skills in each phase of the long jump using a rating scale of 1 to 5, covering the approach, takeoff, flight, and landing. This instrument was adapted from the *Rubric of Long Jump Technique Evaluation* (Subiyanto et al., 2023). In addition, researchers also used video recordings with the help of the Kinovea application to analyze students' push-off angles, horizontal speed, and body position. This visual data was used to provide direct biomechanical feedback during the learning process. Field notes were used to record students' responses, difficulties, and changes in motor behavior during the activity.

The research procedure was conducted through four main stages: preparation, pretest, treatment implementation, and posttest. During the preparation stage, researchers developed biomechanics-based learning tools such as lesson plans and learning media, and trained teachers and observers in using the Kinovea application. The next stage was the pretest, in which students were asked to perform a long jump using their usual technique. The pretest results were used as baseline data for students' basic technical skills.

Next, a biomechanical approach was implemented over four sessions. At each session, students learned the phases of the long jump movement with explanations of the appropriate biomechanical principles. For example, in the takeoff phase, students were given an understanding of the importance of foot angle and vertical force on jump distance. The teacher provided biomechanical feedback in the form of corrections to body position, starting speed, and movement control based on observations and video analysis. The final stage was a posttest, in which students again performed the long jump using the techniques they had learned. Posttest results were compared with pretest results to assess improvements in basic technical skills.

The data obtained were then analyzed quantitatively and qualitatively. Quantitative analysis was conducted by calculating the mean value, standard deviation, and percentage increase in student abilities. To determine the significance of the increase, a paired sample t-test was used

after the data were tested for normality and homogeneity. Meanwhile, qualitative analysis was conducted by describing the results of observations and video recordings to interpret changes in student movement, including improvements in coordination, balance, and movement efficiency based on biomechanical principles.

3 Result

The descriptive analysis results show an average increase in students' basic long jump technique skills after participating in biomechanics-based learning.

Table 1. Descriptive Results of the Pretest and Posttest

Statistics	Pretest	Posttest
N	30	30
Mean	64.23	78.90
Std. Deviation	6.42	5.87
Minimum	52	68
Maximum	76	88

Table 1 shows the descriptive results of students' basic long jump skill scores during the pretest and posttest. Before the treatment, the average student score was 64.23 with a standard deviation of 6.42, indicating variation in ability among students. After being taught using a biomechanical approach, the average score increased to 78.90 with a standard deviation of 5.87, indicating increased consistency and equality of student ability. This average increase of 14.67 points indicates that most students experienced significant improvement in their abilities after the training. Furthermore, the minimum score increased from 52 to 68, and the maximum score from 76 to 88, indicating that improvement occurred not only among high-ability students but also among students with low initial ability.

Table 2. Results of the Kolmogorov–Smirnov Normality Test

Variables	Kolmogorov–Smirnov	Sig. (p)
Pretest	0.135	0.200
Posttest	0.112	0.200

Table 2 displays the results of the data normality test using the Kolmogorov–Smirnov test in SPSS version 25. Based on the test results, the significance value (Sig.) for the pretest and posttest data is 0.200, which is greater than the significance limit of 0.05. This indicates that both data groups are normally distributed. Thus, the assumption of normality is met, so the data is suitable for analysis using the parametric Paired Sample t-Test. The normal distribution of the data also indicates that the distribution of student scores is relatively balanced around the average, and there are no extreme values that can interfere with the results of the statistical analysis.

Table 3. Results of Homogeneity Test

Levene Statistic	df1	df2	Sig.
1.287	1	58	0.262

Table 3 shows the results of the homogeneity of variance test using Levene's Test. The analysis yielded a significance value of 0.262, which is greater than 0.05. This indicates that the variance between the pretest and posttest scores is homogeneous, meaning that the data distribution in both groups has similar variability. This homogeneity of variance is important

because it is a prerequisite for conducting a paired sample t-test. With these results, further analysis can be conducted without the need for data transformation, and the statistical test results can be interpreted validly..

Tabel 4. Paired Samples Statistics

Variabel	Mean	N	Std. Deviation	Std. Error Mean
Pretest	64.23	30	6.42	1.17
Posttest	78.90	30	5.87	1.07

Tabel 5. Paired Samples Correlations

Variabel	N	Correlation	Sig.
Pretest–Posttest	30	0.624	0.000

Tabel 6. Paired Samples Test

Variabel	Mean Difference	Std. Deviation	t	df	Sig. (2-tailed)
Posttest – Pretest	14.67	5.42	9.214	29	0.000

Table 6 displays the results of the Paired Sample t-Test to determine the significant difference between the pretest and posttest results. Based on the results of the SPSS analysis, the calculated t value was 9.214 with degrees of freedom (df) = 29 and a significance value (Sig. 2-tailed) of 0.000, which is less than 0.05. These results indicate that there is a significant difference between the pretest and posttest scores, so it can be concluded that the application of the biomechanical approach has a significant effect on improving students' basic long jump technique skills. The average difference (mean difference) of 14.67 points shows a significant increase in practical terms, not only statistically significant. This indicates that the biomechanical approach has succeeded in providing substantial changes in mastery of basic techniques.

Tabel 7. Skill Improvement Percentage

Indicator	Pretest (Mean)	Posttest (Mean)	Improvement (%)
Basic Long Jump Technique Skills	64.23	78.90	22.8%

4 Discussion

The results of the study showed that the application of a biomechanical approach had a significant effect on improving basic long jump technical skills in elementary school students. Based on data analysis using SPSS version 25, the average student skill score increased from 64.23 to 78.90, with a significance value of 0.000 ($p < 0.05$). This result indicates that there is a significant difference between initial abilities and abilities after being given treatment. These findings show that the application of a biomechanical approach can improve movement understanding, correct technical errors, and optimize students' long jump performance.

The significant results of the paired sample t-test indicate that the application of biomechanical principles during the learning process has a measurable impact on motor skill changes. This finding is supported by research (Ahmad et al., 2024), which explains that a biomechanical-based approach can correct takeoff and landing errors in novice athletes. Thus,

the skill improvements experienced by the Tamannyeleng Elementary School students in this study demonstrate that biomechanical principles can also be effectively applied at the elementary school level with appropriate pedagogical adjustments.

During the hover phase, students were able to maintain their balance in the air with greater control, while during the landing phase, they demonstrated the ability to place their feet parallel and maintain body stability upon contact with the ground. Improvements in each phase demonstrate the effectiveness of the biomechanical approach in increasing movement efficiency and reducing the risk of errors or injuries. The study also demonstrated that the 22.8% increase in fundamental technical skills reflected not only a numerical increase but also an improvement in the quality of students' biomechanical understanding of movement. This means that this approach helps students develop a scientific foundation for physical activity, which they can later apply to other sports.

5 Conclusion

Based on the research results and data analysis, it can be concluded that the application of a biomechanical approach in teaching basic long jump techniques has a significant impact on improving elementary school students' abilities. This approach enables students to understand the relationship between force, takeoff angle, and starting speed, resulting in a more efficient jump. Statistical tests showed an average increase of 14.67 points with a significance level of $p < 0.05$, indicating that the increase was significant and did not occur by chance.

In addition to quantitative improvements, observations also showed positive changes in the quality of students' movements during each phase of the long jump. Students were able to maintain body balance, regulate the rhythm of their starting steps, execute the takeoff at an optimal angle, and achieve a more stable landing. These improvements demonstrate that the biomechanical approach not only improves motor skills but also strengthens students' conceptual understanding of the scientific principles of sports.

Thus, it can be concluded that the biomechanical approach is suitable for implementation in physical education learning in elementary schools because it supports active, scientific, and meaningful learning. Teachers are advised to utilize visual media, such as video analysis, as a tool in providing more concrete biomechanical feedback. Furthermore, further research is recommended to explore the application of the biomechanical approach in other sports, such as high jump or sprint, so that the results can be compared and implemented more widely in the context of physical education in schools.

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