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Enhancing Students' Statistical Literacy Through Physical Education Long Jump Athletics Learning at Elementary School

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ABSTRACT

This study aims to improve elementary school students' statistical literacy through Physical Education (PJOK) learning, particularly in the long jump athletic material. The study used a quasi-experimental method with a pre-test post-test control group design. This research was conducted at SD Muhammadiyah 2 Kota Sorong with a total sample of 56 sixth-grade students, divided into two groups: the experimental class applying PJOK learning based on long jump athletics and the control class using a conventional learning model. Data were collected through pre-test, post-test, questionnaires, and observations of student activities. The results showed a significant improvement in statistical literacy in the experimental group compared to the control group. The t-test revealed a significance value indicating a significant difference between the two groups in achieving statistical literacy. The average N-Gain increase in the experimental group categorized as high, while the control group in moderate category. Additionally, students' responses to the learning model were positive. Based on these findings, it can be concluded that PE learning based on long jump athletics is effective in improving elementary students' statistical literacy. This learning model not only enhances conceptual understanding but also develops data analysis skills in real-world contexts.

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A. INTRODUCTION

Primary school is the initial stage of formal education that plays a crucial role in shaping a generation that is intelligent, creative, and capable of adapting to the era of globalization and the current advancements in information technology. One of the essential skills relevant in the context of an education system that involves various concepts and skills to solve problems and understand the world around us is statistical literacy. Therefore, statistical literacy is an essential aspect that students need to develop life skills to face the Industrial Revolution 4.0. This statistical literacy ability is highly useful in equipping students with the capacity to collect, understand, process, analyse, and critically interpret data and information (Đono et al., 2022).

Statistical literacy in the mathematics curriculum includes understanding basic statistical terms, recognizing the use of statistical symbols, and the ability to identify and comprehend data-based (statistical) information (Bargagliotti et al., 2020; Schreiter et al., 2024) These skills serve as a critical foundation that must be instilled from an early age to prepare students for

the data-driven era (OECD, 2019). The essence of literacy is not only about reading and writing activities, but more than that, literacy also involves critical thinking skills, especially in processing complex information (Goodsett, 2020). In this context, literacy is a crucial aspect to be developed in all fields of science, including statistical literacy (statistical awareness). Support from international teacher professional organizations, such as in the United States and New Zealand, has emphasized the importance of statistical literacy as part of educational research to help students systematically solve data-based problems (Masfingatin & Suprapto, 2020). Statistical literacy enables students to understand the processes of data collection, analysis, and scientific conclusion drawing (Maryati & Priatna, 2018). Ultimately, students will encounter data and information in their daily lives, demonstrating that the need for statistical competence is absolute. A simple example is how society often faces media that presents data, either in the form of graphs or texts, where they must be able to analyse the data to draw accurate conclusions. To reach correct conclusions, society needs to at least understand basic statistics to differentiate credible information from non-credible ones and critically evaluate the information (Gal, 2002; Schreiter et al., 2024; Yuniawatika, 2018).

The critical role of statistics in life requires special attention in the education curriculum. In the curriculum of subjects at the elementary and secondary school levels, statistics is an integrated part of mathematics subjects. Understanding statistical concepts from an early age is crucial, considering the growing need for data analysis skills in various life aspects. As an initial step in building statistical literacy, students need to grasp basic statistical concepts, including how to collect data and draw conclusions based on processed data (Sharma, 2017). Good statistical literacy not only supports students' understanding of mathematics but also equips them with relevant analytical skills in an increasingly data-driven future (Guide, 2017; Schreiter et al., 2024). Although statistical literacy is considered crucial, implementing statistical literacy in the mathematics curriculum at the elementary school level still faces several challenges. Limited learning time, lack of teaching innovation, and students' limited experience in understanding practical statistical concepts are major obstacles. Moreover, statistical literacy is often perceived as abstract by students because it is rarely applied in meaningful and relevant learning contexts to everyday life. In line with research (Repedro & Diego, 2021), high school students tend to see statistical literacy as highly useful for their personal and professional lives in the future, even though they may not necessarily have good statistical literacy skills (Kurnia et al., 2023).

In the context of statistics, the types of errors made by students include formula usage errors, calculation operation errors, and errors due to carelessness, where students may not recheck the answers they have completed (Jurnal et al., 2023). The factors contributing to these errors involve conceptual errors, principle errors due to a lack of understanding of the questions, and operational or calculation errors. Understanding the types of errors and their contributing factors can help educators and students more effectively correct and prevent these errors. Based on the research results, it is necessary to consider teaching methods that can help students overcome difficulties, one of which is through a more interactive and practical approach (Arsyad et al., 2023). Previous research has identified four main factors influencing the development of statistical literacy among students: the learning environment, students' attitudes, teaching methods, and students' basic knowledge (Aziz & Rosli, 2021).

Furthermore, another study explained that the inability in statistical literacy could be attributed to the lack of deep learning experiences for students in interpreting statistical information (Yolcu, 2014). Enhancing statistical literacy requires more innovation, strategies, and thorough preparation in designing teaching materials to learn statistics. Innovative approaches and strategies applied include student-centered learning, such as guided discovery learning with a contextual approach, where students are more active in constructing their knowledge and understanding the relevance of the taught material to real-world conditions they face (Bremner et al., 2022). The use of real data in statistics also helps students realize the importance of statistics in everyday life, thus enhancing their statistical literacy (Ridgway, 2016). Additionally, the habit of providing non-routine problems related to statistical material containing elements of daily life will train students' higher-order thinking skills in solving statistical problems.

The existence of data is very useful in decision-making processes, evaluating something, and for various other purposes. The science that studies data is known as statistics. Statistics is a branch of mathematics that focuses on basic knowledge from data collection to developing data interpretation skills (Rumsey, 2002). Talk about statistical literacy, literacy is not only about reading but also involves the ability to interpret, respond to the truth of information, and apply it in daily life (Jailani et al., 2020). Meanwhile, according to Schield (2022), statistical literacy is the ability to read and interpret data, including the skills to use statistics as evidence in an argument. Statistical literacy consists of five competencies: understanding statistical concepts, understanding the application of statistical concepts, numeracy skills and graph creation, data interpretation skills, and data visualization and communication skills (Tiro et al., 2021). In line with this, statistical literacy is a skill in interpreting, critically evaluating, and communicating information and statistical messages, including understanding and using the basic language and tools of statistics (Garfield et al., 2010).

Statistics is taught at various educational levels, from elementary to high school. At the elementary level, statistics education focuses on introducing basic concepts according to students' cognitive development (Hijazi & Shaqlaih, 2023). The basic competencies that must be mastered include the ability to collect and present simple data, read and interpret data, calculate average values, mode, and median, and understand the concept of probability intuitively. In data analysis, students begin to understand the concept of the average value by calculating simple data, recognizing the mode as the most frequently appearing value, and the median as the middle value in ordered data. Moreover, they are also introduced to probabilities in everyday life, such as the likelihood of a specific number appearing when rolling a dice or the chance of getting a particular colour when picking a ball from a box. With this basic understanding, students will have a strong foundation to learn more complex statistics in junior and senior high school. Thus, in the context of statistical education, it is not only related to numbers but also facilitates a context that makes problems more realistic (Cobb & Moore, 1997).

The urgency in this matter is highlighted by several studies conducted at the junior high school level, showing that students' statistical literacy abilities are still at a low to moderate level (Ridgway et al., 2011; Utomo, 2021), raising concerns that the statistical literacy ability at the elementary school level may also be low. This situation drives the need to develop students'

statistical literacy from an early age. Equipping students with basic skills in obtaining and processing data at the elementary school level is a fundamental skill that must be possessed in statistical literacy (Witte et al., 2025). One alternative to building students' statistical literacy is by teaching them to obtain and process data through PJOK (Physical Education, Sports, and Health) learning athletic long jump.

The long jump is one of the athletic sports taught in physical education learning in elementary schools. This sport aims to train students' strength, speed, coordination, and motor skills. The long jump is performed by running towards the take-off board, jumping as far as possible into the sandpit, and landing properly. In elementary school learning, the basic long jump techniques taught include four main stages: approach, take-off, flight, and landing (Fardillah et al., 2019). The approach is done by running fast towards the take-off board to gain maximum speed. The take-off is performed with one foot on the board to generate upward thrust. The flight movement aims to maintain body balance in the air before landing in the sandpit with both feet parallel and knees slightly bent to avoid injury (Bakar et al., 2024). Long jump learning in elementary schools focuses more on mastering basic techniques simply and enjoyably. Teachers can use various methods, such as games or varied exercises, to make students more interested and easily understand the basic concepts of the long jump.

This study aims to analyse how to enhance students' statistical literacy skills at the elementary school level through the integration of statistics with other subjects, particularly PJOK, with the aim of promoting the improvement of students' abilities in the field of statistics. The objective of this study is to analyse how to enhance students' statistical literacy skills by implementing statistical literacy in elementary schools, developed through PJOK long jump athletics lessons.

B. METHODS

The type of research conducted is experimental research using a pre-test post-test control group design. The research consists of two groups: the experimental group, which integrates statistical literacy through PJOK athletics long jump learning, and the control group, which uses a conventional learning model. This study used purposive sampling in which the selection of the school was based on the geographic similarity of the area to ensure the homogeneity of the local context and the potential influence of local wisdom that could affect the research focus in a similar way. This research was conducted at SD Muhammadiyah 2 Kota Sorong with the research subjects being sixth-grade students. Prior to sampling, a homogeneity and variance test conducted to ensure the population was homogeneous. Based on this technique, class 6B was selected as the experimental class with 26 students, and class 6A was chosen as the control class with 26 students. Data collection for hypothesis testing was carried out in four meetings in both the experimental and control classes. The quasi-experimental research design with the pre-test post-test control group design can be seen in the following Table 1.

Table 1. Research Design

Group	Pre-test	Treatment	Post-test
E	O_1	X	O_2
C	O_1		O_2

Description:

E : Experimental Group
O_1 : Pre-test Results
X : Treatment using the implementation of statistical literacy in Physical Education (athletics long jump)
O_2 : Post-test Results

Data collection techniques were carried out using pre-test, post-test, questionnaires, and observation to monitor student activities during the learning process. The pre-test and post-test were designed to measure the students' statistical literacy before and after the intervention. The questionnaires were used to gather student feedback on the learning model, and the observations monitored student engagement and participation. The instruments used in this study included a set of questions related to statistical literacy, which were designed to assess students' understanding of basic statistical concepts. The validity of the instruments was ensured through expert reviews and pilot testing, while reliability was confirmed through a Cronbach's alpha coefficient, which demonstrated adequate internal consistency. The data analysis techniques used in this study included the normality test to ensure that the data were normally distributed, the homogeneity test, and the independent t-test to analyse differences in the average pre-test and post-test scores of students' statistical literacy. These statistical methods were applied to determine the effectiveness of the learning model in improving students' statistical literacy. The research procedure consisted of three stages: the preliminary stage, the implementation stage, and the final stage, as shown in Figure 1.

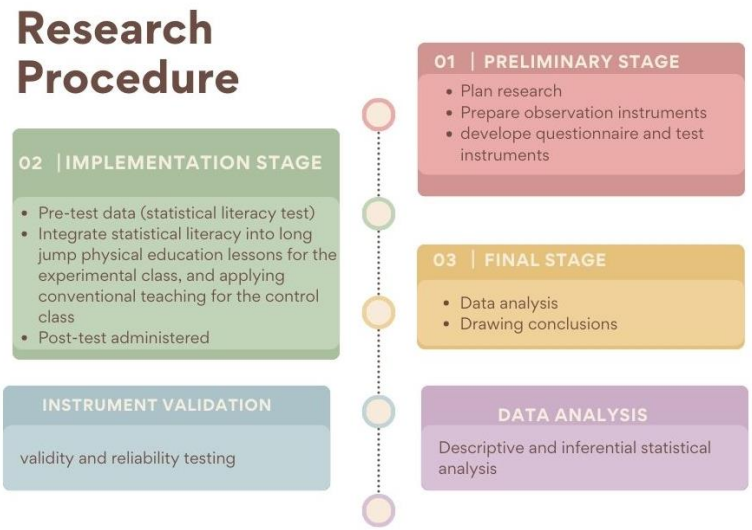

Figure 1. Stages of the Research Procedure

C. RESULT AND DISCUSSION

1. Result

Based on the results of the descriptive data analysis of students' statistical literacy in both classes, it was found that in class 6A with conventional learning, the distribution of statistical literacy scores showed that 1 student scored between 65≤LS<75, while 26 students were in the range of 75≤LS<100. In contrast, in class 6B as the experimental class, the results showed that no students were in the range of 0≤LS<65. However, 100% of the students achieved scores in the range of 75≤LS<100. This achievement can be seen in the following categorization in Table 2.

Table 2. Score Categories

Score	Categories	6 A	6 B
$0 \leq LS < 45$	Very poor	0	0
$45 \leq LS < 65$	poor	0	0
$65 \leq LS < 75$	Fair	1	0
$75 \leq LS < 90$	Good	17	12
$90 \leq LS < 100$	Very Good	8	15

After analyzing the differences in student learning outcomes between class 6A, which used conventional learning methods, and class 6B, which used statistical literacy learning through PJOK athletics long jump, it was found that the average pre-test score for class 6A was 45.58, while class 6B had an average pre-test score of 43.33. After the learning process, the average post-test score for class 6A reached 84.42, while class 6B achieved an average post-test score of 88.52. The increase in the average score in class 6A from pre-test to post-test was 38.84 points. On the other hand, class 6B showed a higher increase of 45.19 points. These results indicate that the implementation of statistical literacy learning through PJOK athletics long jump in class 6B had a more significant impact on improving student learning outcomes compared to the conventional learning method in class 6A. Table 3 below presents the comparison of pre-test and post-test mean scores, along with the calculated N-Gain and its category for both the control and experimental classes.

Table 3. N-Gain Comparison Between Control and Experimental Classes

Class	Pre-test Mean Score	Post-test Mean Score	N-Gain	Category
Class 6A	45.58	84.42	0.689	Moderate
Class 6B	43.33	88.52	0.790	High

Table 3 shows that the experimental class (Class 6B) obtained a higher N-Gain score than the control class. The higher N-Gain of **0.790** in experimental class signifies that the integrated instructional approach was more effective in improving students' statistical literacy compared to the conventional teaching methods used in the control class. The experimental class had a higher improvement in their scores, meaning that the integration of statistical literacy into physical education lessons contributed positively to their learning outcomes. This reinforces the importance of using interdisciplinary approaches in education, where statistical concepts can be better understood when applied in practical, real-life contexts. The higher N-Gain score in the experimental class suggests that such an integrated approach could be a useful teaching

strategy in other educational settings. It implies that students learn better and improve more when subjects are taught in a contextualized and engaging manner, rather than in isolation. This finding has practical significance for educators looking for ways to enhance student learning, as it suggests that integrating subjects like statistical literacy into practical lessons (e.g., physical education) can lead to better student engagement and retention of knowledge. Subsequently, Table 4 displays the descriptive statistics of students' post-test scores in both the control class (Class 6A) and the experimental class (Class 6B), including the number of students, mean, standard deviation, and standard error of the mean.

Table 4. Statistic Group

Group Statistics					
	Group	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Learning outcomes	Class 6A	26	84.4231	6.83036	1.33954
	Class 6B	27	88.5185	7.31369	1.40752

Based on the descriptive statistical analysis in the Group Statistics table 4, the mean score of student learning outcomes in class 6A was 84.42, with a standard deviation of 6.83 and a standard error mean of 1.34. Meanwhile, class 6B had a mean learning outcome score of 88.52, with a standard deviation of 7.31 and a standard error mean of 1.41. These results indicate that class 6B, which used a statistical literacy learning approach through PJOK athletics long jump, had a higher average learning outcome compared to class 6A, which used conventional learning methods.

The relatively small standard deviations in both classes indicate that the distribution of student scores was not too far from the average score, suggesting consistency in student learning outcomes within each class. Additionally, the not-too-significant difference in the standard error mean indicates that the average learning outcomes obtained are a fairly good representation of the student population in each class. The average difference in learning outcomes of 4.10 points serves as an initial indication that the statistical literacy learning approach through PJOK athletics long jump is more effective in improving student learning outcomes compared to conventional learning methods.

Table 5. Homogeneity Test

Test of Homogeneity of Variances					
		Levene Statistic	**df1**	**df2**	**Sig.**
Learning Outcomes	Based on Mean	.483	1	51	.490
	Based on Median	.373	1	51	.544
	Based on Median and with adjusted df	.373	1	50.996	.544
	Based on trimmed mean	.397	1	51	.532

Based on Table 5, the homogeneity of variance test using Levene's Test showed that the significance values (Sig.) for various testing methods were above the threshold value of 0.05. The significance value based on the mean was 0.490, based on the median was 0.544, based on the median with adjusted degrees of freedom (adjusted df) was 0.544, and based on the trimmed mean was 0.532. All these significance values were greater than 0.05, indicating that

the variance of learning outcomes data between the control and experimental classes was homogeneous. This conclusion provides a strong foundation for continuing the hypothesis testing in this study.

Table 6. Normality Test

Tests of Normality							
	Group	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Learning Outcomes	Class 6A	.159	26	.091	.929	26	.073
	Class 6B	.146	27	.148	.939	27	.118
a. Lilliefors Significance Correction							

Based on Table 6, the normality test of learning outcomes data was conducted using the Kolmogorov-Smirnov and Shapiro-Wilk tests. In the Kolmogorov-Smirnov test, the significance value for the control class was 0.091, and for the experimental class, it was 0.148. Meanwhile, in the Shapiro-Wilk test, the significance value for the control class was 0.073, and for the experimental class, it was 0.118. All significance values were greater than 0.05, indicating that the learning outcomes data in both classes were normally distributed. This normality assumption meets the prerequisites for further parametric statistical analysis.

Table 7. Independent t-Test

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Learning Outcomes	Equal variances assumed	.483	.490	-2.105	51	.040	-4.09544	1.94562	-8.00143	-.18946
	Equal variances not assumed			-2.108	50.955	.040	-4.09544	1.94306	-7.99639	-.19450

Based on the results of the Independent Samples Test in Table 7, it is known that testing using Levene's Test for Equality of Variances showed a significance value (Sig.) of 0.490 (> 0.05). This result indicates that the variances of the two data groups (class 6A and class 6B) are homogeneous, allowing the assumption of equal variances assumed to be used in the t-test. In the t-test for Equality of Means, the obtained t-value was -2.105 with a degree of freedom (df) of 51 and a significance value (Sig. 2-tailed) of 0.040. This significance value is smaller than 0.05, indicating a statistically significant difference between the average learning outcomes of students in class 6A and class 6B. Overall, the t-test results support the hypothesis that implementing statistical literacy learning through PJOK athletics long jump in class 6B is more effective in improving student learning outcomes compared to the conventional learning method in class 6A. Thus, using innovative and statistical literacy-based learning methods can positively impact improving the quality of learning at the elementary school level.

2. Discussion

In this study, statistical literacy was integrated into PJOK learning through athletics long jump to enhance elementary school students' ability to understand and process data. Based on the research findings, it was found that statistical literacy learning through this approach was more effective than conventional learning. A significant improvement was observed in students who participated in learning with the statistical literacy integration approach, where their average post-test scores were higher than those in the group using conventional learning methods. The normalized gain (N-Gain) in the experimental class reached 0.790 or 79%, which falls into the high category. Meanwhile, the control class only achieved an N-Gain of 0.689 or 68.9%, categorized as moderate. This substantial difference of more than 10 percentage points indicates that the integration of statistical literacy into PJOK learning—specifically through the long jump activity—had a stronger impact on improving students' understanding and application of statistical concepts compared to conventional methods.

These findings are in line with and extend previous studies. For example, Aziz & Rosli (2021) reported a moderate N-Gain of 0.67 in their study, which involved middle school students using integrated learning materials for statistics. Similarly, Hariyanti & Wutsqa (2020) found an N-Gain of 0.72 when applying a contextual-based guided discovery approach. Compared to those studies, the 0.79 N-Gain achieved in this research demonstrates a more substantial improvement, likely due to the combination of physical engagement, real-life data collection, and meaningful context provided in the PJOK learning setting. This finding addresses the research problem regarding how to improve elementary school students' statistical literacy. Consistent with previous research (Aziz & Rosli, 2021; Yolcu, 2014), innovative approaches in learning, such as integrating statistical literacy with PJOK subjects, can have a greater impact on students' understanding and application of statistical concepts. It also demonstrates that statistical literacy, often considered abstract and difficult to grasp, can become more relevant and meaningful when applied in real-life contexts close to students' experiences.

Additionally, this finding confirms the importance of contextual and data-driven learning in developing statistical literacy, as described by (Ridgway, 2016) and (Hariyanti & Wutsqa, 2020). Learning using real data and questions related to everyday life allows students to better understand the importance of statistics in various contexts, such as in sports data analysis. This is also in line with the theory of statistical literacy, which suggests that students should not only understand basic concepts but also be able to critically interpret data (Garfield et al., 2010; Schield, 2022). Integrating statistical literacy into PJOK learning, particularly in athletics long jump, also helps build higher-order thinking skills in students. This learning not only teaches students to calculate and interpret data but also trains them to think analytically when dealing with complex information. Thus, such learning can play a role in addressing the main challenges faced in teaching statistics in elementary schools, such as the lack of innovation in teaching methods and the disconnect between the material and students' daily lives. Going forward, it is important to continue developing innovative learning methods that integrate statistical literacy into various other subjects to enrich students' learning experiences and equip them with the necessary skills to face challenges in this data-driven era.

D. CONCLUSION AND SUGGESTIONS

Based on the research results, it can be concluded that integrating statistical literacy into PJOK learning through athletics long jump in elementary schools has a significant impact on improving students' statistical literacy skills. The findings show that the experimental class achieved a high N-Gain score. Furthermore, statistical analysis through a t-test revealed a significant difference between the pre-test and post-test scores of both classes. It's supporting the effectiveness of the integrated instructional approach in enhancing students' statistical literacy skills. These key figures N-Gain values and t-test results reinforce the conclusion that the integration of statistical literacy into PJOK lessons significantly improves students' learning outcomes in statistical literacy. This learning method showed better results compared to conventional learning, as reflected in the increase in the average scores of students in the experimental group. This approach demonstrates that statistical literacy material, which is often considered abstract, becomes more meaningful and relevant when applied in real-life contexts, such as in sports data analysis. Moreover, the use of real data and questions related to everyday life helps students understand the importance of statistics and develop critical thinking skills needed in the data-driven era.

As a suggestion, elementary school teachers are encouraged to integrate statistical literacy into other subjects, such as PJOK, to provide a more relevant and engaging context for students. Learning that connects material with everyday life can enhance students' understanding of statistical concepts and develop their analytical skills. It is also hoped that curriculum managers at the primary education level will pay more attention to integrating statistical literacy into the mathematics curriculum and other subjects. Developing more contextual and data-based materials will greatly support the effective development of statistical literacy among students. However, it should be noted that this study was limited in scope, focusing only on one subject area athletic long jump in PJOK—and was conducted within a specific geographical area, which may affect the generalizability of the findings. Future research involving various subjects and broader school populations is recommended to validate and expand the results. From a practical standpoint, the findings of this study imply the need for policy support to encourage interdisciplinary learning approaches in primary education. Curriculum developers and educational policymakers should consider systematically embedding statistical literacy in both core and non-core subjects. By implementing more innovative and data-driven methods, it is expected that statistical literacy at the elementary level will improve, preparing students to better face future challenges in an increasingly data-driven world.

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