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Implementation of Local Wisdom-Based STEM Integrated PBL Learning Devices (Gasingan) to Improve Students' Creative Thinking Skills

Fadhila Zilfa Zen*, Haerul Pathoni, Erlida Amnie
Physics Education, Jambi University
***Corresponding Author e-mail: fadhilaazilfazen@gmail.com**

Abstract: This study aims to investigate the effectiveness of implementing STEM-integrated Problem-Based Learning (PBL) instructional tools based on local wisdom (Gasingan) in improving students' creative thinking skills on the topic of rotational dynamics at SMA Negeri 11 Kota Jambi. The research employed a quantitative approach using a quasi-experimental design with a non-equivalent control group, involving an experimental class and a control class. The experimental class received STEM-integrated PBL learning, while the control class was taught using conventional methods. Both groups were given pretests and posttests to measure students' creative thinking skills. Data were analyzed using SPSS and manual calculations via Microsoft Excel. The results showed a significant increase in students' creative thinking skills in the experimental class, as indicated by the Paired Sample T-test with a significance value of 0.000 ($p < 0.05$). The improvement was greater than in the control class, suggesting that the use of STEM-integrated PBL tools enriched with local wisdom positively impacted students' engagement and cognitive development in learning physics, particularly in understanding rotational dynamics concepts.

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Introduction

Physics education plays a crucial role in providing a deep understanding of the fundamental principles of the universe that underlie various natural phenomena and modern technologies around us. However, efforts to achieve the goals of science education, particularly in physics, still face various challenges, one of which is the use of less effective teaching methods. Higher-order thinking aspects such as analysis and evaluation are often overlooked, as the learning process tends to focus more on memorizing, understanding, and applying. According to Rohim et al. (2012), these deeper aspects are often not given sufficient attention. Learning tools such as syllabi, lesson plans (RPP), teaching materials, modules, worksheets, and learning outcome tests are essential for improving the quality of the learning process. These tools are designed to ensure that learning runs systematically and in a structured manner, thus helping teachers deliver the material and students grasp the concepts more easily. Effective learning tools should also be adapted to current demands, such as the integration of digital

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technology, to enhance student engagement and motivation. Arvianto et al. (2020) state that technology-integrated learning tools can facilitate more interactive and effective learning, particularly in developing creative thinking skills.

Problem-Based Learning (PBL) is a learning model that presents problems relevant to real-life contexts (Kemendikbud, 2014), encouraging students to collaborate in groups to find solutions. PBL learning tools include various materials and resources that support problem-based learning processes. This model is effective in training students' thinking skills and developing affective competencies such as character and communication. PBL helps teachers create a learning environment that begins with the presentation of significant and relevant problems, allowing students to gain deeper and more meaningful learning experiences. The learning tools in the PBL model include resources and instruments that support active student learning. According to Hadi et al. (2022), implementing PBL integrated with STEM (Science, Technology, Engineering, and Mathematics) facilitates students in practicing problem-solving skills. Learning tools within the STEM-integrated PBL model are designed to enhance students' critical thinking, creativity, and problem-solving abilities. Through this approach, students not only learn theoretical concepts but also apply their knowledge to real-world problems, making the learning process more meaningful and engaging.

Learning tools based on local wisdom are an innovation that integrates cultural values and local knowledge into the learning process. Preserving local wisdom can reduce the negative impacts of globalization and modernization, which often influence the behavior of young people, including students (Sarah et al., 2014). These tools are designed to make learning materials more relevant to students' daily lives, allowing them to better understand and apply the knowledge gained. The use of local wisdom also strengthens cultural identity and fosters pride in one's heritage. Problem-Based Learning (PBL) based on local wisdom uses local environmental or contextual issues as the foundation for learning. Through this approach, students can more easily grasp and apply concepts because they are directly related to their everyday experiences. According to Ariffiando et al. (2023), this method not only enhances critical and creative thinking skills but also nurtures a love for local culture and environment. One traditional game from Jambi is gasingan, a spinning top that rotates on its axis and balances on a single point. Gasingan strengthens cultural identity and instills pride in local heritage among children and adults alike. It is a form of recreation that carries educational values, helping players develop various skills and enjoy social interaction (Gunawan et al., 2024). This game not only entertains but also supports physics learning by illustrating concepts like moment of inertia and centripetal force, making it ideal for classroom integration.

Based on previous research conducted by Maydilla et al. (2023), the implementation of PBL (Problem-Based Learning) learning tools integrated with STEM and local wisdom can enhance students' creative thinking skills. The PBL model with a STEM approach is effective in developing students' mathematical creative thinking abilities, which include the aspects of fluency, originality, flexibility, and elaboration. The use of Student Worksheets (LKPD) as a means of implementing PBL integrated with STEM helps students not only focus on solving mathematical problems but also connect knowledge from other disciplines within the STEM context, thereby equipping them with optimal creative thinking skills.

The integration of STEM in learning also serves to foster 4C skills (critical thinking, creativity, collaboration, and communication), which are essential for facing global challenges. Through this approach, students are expected to acquire new knowledge and develop their thinking in solving problems, thus enhancing their creative thinking abilities. According to

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Vistara et al. (2022), PBL learning tools integrated with STEM and local wisdom can improve students' creative thinking skills. The implementation of the PBL model allows students to solve problems independently or in groups using their reasoning. The problems presented to students not only focus on mathematics but also involve other disciplines within STEM, enabling them to optimally develop their creativity. Syahrir (2016) states that creative thinking-based learning tools consist of lesson plans (RPP) and student worksheets (LKS). Creative thinking skills play a crucial role in problem-solving, especially in physics, and include characteristics such as fluency, flexibility, originality, and elaboration. These skills allow individuals to generate diverse, authentic, and detailed ideas and solutions. Creative thinking can be cultivated through learning methods that encourage open-mindedness and exploration of various possibilities, making it a vital element in education aimed at developing higher-order thinking skills.

The results of an interview with a physics teacher at SMA N 11 Kota Jambi revealed that there are currently no learning tools incorporating Jambi's local wisdom at the school. In addition, the learning model used still relies on direct instruction through lectures, with no implementation of problem-based learning. The integration of the STEM approach in the learning tools is also not yet optimal, and therefore has not fully supported the development of students' creative thinking skills.

This research was conducted to develop and implement PBL-based learning tools integrated with STEM, utilizing local wisdom in the form of the traditional game "Gasing" as a learning medium. The subject matter examined in this study is rotational dynamics, in which students will be actively involved in problems relevant to physical phenomena observed in the gasing game. Through this research, it is expected that students will enhance their creative thinking skills and gain a deeper understanding of physics concepts within the context of local culture. In addition, this study will also evaluate the effectiveness of the developed learning tools in improving students' understanding and creativity, while contributing to the development of more innovative and contextual physics learning strategies in the future. Based on the results of observations, the researcher will carry out a study entitled "Implementation of STEM-Integrated PBL Learning Tools Based on Local Wisdom (Gasingan) to Improve Students' Creative Thinking Skills."

This study aims to determine the extent to which the implementation of Problem-Based Learning (PBL) instructional tools integrated with the STEM approach can enhance students' creative thinking skills in the topic of rotational dynamics at SMA Negeri 11 Kota Jambi. Through this approach, students are expected to actively engage in the learning process, identify problems relevant to real-life situations, and develop creative solutions through collaboration and the application of interdisciplinary knowledge in science, technology, engineering, and mathematics. This study also aims to evaluate the effectiveness of the developed instructional tools in supporting students' competency achievement, particularly in creative thinking, so that it can serve as an alternative for innovative and contextual physics learning strategies in the future.

Research Method

This study falls under quantitative research using the quasi-experimental method. According to Ramdhan (2021), quantitative research is a method expressed in numerical form obtained from the field, typically conducted on a large scale and involving random sampling to ensure the validity of the results. This research targets a specific population or sample,

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utilizes research instruments for data collection, and applies quantitative or descriptive data analysis. Rukminingsih et al. (2020) state that quasi-experimental research is a development of true experimental design, which is often difficult to implement, especially in the fields of social sciences and education. This design includes a control group, but it does not fully control for external variables that may influence the research results. The method is used to determine differences in students' creative thinking abilities between those taught using a problem-based learning model and those taught using conventional methods. This study used a non-equivalent control group design, involving two groups: the experimental group and the control group, each receiving different treatments. The experimental group was taught using a STEM-integrated PBL model based on local wisdom, while the control group received conventional instruction. Both groups were given a pretest before the treatment to assess their initial creative thinking abilities, followed by a posttest after the treatment to evaluate the development of their creative thinking skills following the different instructional approaches.

Table 1. Research Design Non-equivalent Control Group Design

Group	Pretest	Behavior	Posttest
Experiment	O_1	X_1	O_2
Control	O_3	X_2	O_4

(Source: Rukminingsih et al., 2020))

According to Garaika (2019), a population is the generalization area of subjects that possess specific characteristics. In other words, the population refers to all research subjects. The population in this study consists of all eleventh-grade students in phase F at SMA Negeri 11 Kota Jambi, totaling four classes. Meanwhile, a sample is defined as a portion of the population that reflects its quantity and characteristics (Setyaningrum et al., 2020). In this study, the sample includes students from class XI phase F3, totaling 32 students, who were assigned as the control group, and students from class XI phase F4, totaling 36 students, who were assigned as the experimental group.

The sampling technique used in this study is purposive sampling. Etikan et al. (2016) state that purposive sampling is a non-random sampling technique that does not require an underlying theory or a specific number of participants. In purposive sampling, researchers do not select samples randomly but instead intentionally choose them to ensure that the selected samples reflect specific characteristics relevant to the study. The reason for using purposive sampling is that not all potential samples meet the criteria related to the phenomenon being investigated. Therefore, the researcher chose this technique based on certain considerations or criteria that must be fulfilled by the samples used in this study.

This study uses inferential statistics because it is conducted on a sample that represents the population. By collecting data from the sample, the analysis can be generalized to the wider population. Before performing data analysis, several products used in the study—such as the teaching module, student worksheet (LKPD), and observation sheet—must first be validated. The data analysis includes several steps. The first is the normality test, which, according to Kadir (2015), is a preliminary analysis used to determine whether a statistical method is appropriate for hypothesis testing. This test ensures that the data meet the assumptions required by the statistical method. The Kolmogorov-Smirnov test is used in this study because the sample consists of more than 50 students. Andani (2015) states that the Kolmogorov-Smirnov test is suitable for sample sizes above 50, while the Liliefors and Shapiro-Wilk tests are used for smaller samples. The decision rule for the SPSS output is: if the significance value is greater

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than 0.05, the data are normally distributed (H_0 accepted); otherwise, they are not normally distributed (H_1 accepted). If the data are normally distributed, a paired t-test is conducted. The next step is the homogeneity test, which determines whether two or more sample groups come from populations with equal variances. Levene's Test is used to test for significant differences in variance between the experimental and control groups. According to Sianturi (2022), the hypothesis is accepted if the significance value is greater than 0.05, indicating homogeneity. Finally, the t-test is used to measure the effect of each variable. This study applies the Paired Sample t-Test to compare the pretest and posttest results, evaluating the effectiveness of the experimental intervention. The test is conducted using SPSS software, where the pretest and posttest are considered as paired observations from the same subjects.

Result and Discussion

Result

Results of Pretest and Posttest Normality Test

In this study, the normality test was applied to four data groups: the pretest and posttest scores of creative thinking skills for both the experimental and control classes.

Table 2. Results of Pretest and Posttest Normality Test

Tests Of Normality

		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
Results	Pretest Experimental Class	,116	27	,156
	Posttest Experimental Class	,103	27	,158
	Pretest Control Class	,114	27	,168
	Posttest Control Class	,060	27	,200

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on Table 2, the significance values for the pretest and posttest in the experimental class were 0.156 and 0.158, respectively, while in the control class, the pretest significance value was 0.168 and the posttest value reached 0.200. Data are considered normally distributed if the significance value is greater than 0.05 (sig > 0.05). Therefore, based on the analysis results presented in Table 4.53, the pretest and posttest data in both the experimental and control classes can be concluded to be normally distributed, as all significance values exceed 0.05.

Self-Assessment Normality Test Results Before and After Treatment

In this study, the normality test was applied to four data groups, namely self-assessment data before and after treatment related to creative thinking skills in both the experimental and control classes.

Table 3. Self-Assessment Normality Test Results Before and After Treatment

Tests Of Normality

	Kolmogorov-Smirnov[a]		
Class	Statistic	df	Sig.

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Results	Prior Self-Assessment Experimental Class	,090	27	,200*
	Self-Assessment After Experimental Class	,142	27	,181
	Prior Self-Assessment Control Class	,094	27	,200*
	Self-Assessment After Control Class	,131	27	,147

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Based on Table 3, the significance values for the self-assessment data before and after treatment in the experimental class were 0.200* and 0.181, respectively. Meanwhile, in the control class, the significance values before and after treatment were 0.200* and 0.147, respectively. Data are considered normally distributed if the significance value is greater than 0.05 (sig > 0.05). Therefore, based on the results presented in Table 4.54, both the self-assessment data before and after treatment in the experimental and control classes can be declared normally distributed, as all significance values exceed 0.05.

Results of the Pretest Homogeneity Test of the Experimental and Control Classes

In this analysis, the homogeneity test was conducted to evaluate the pretest results of creative thinking skills in both the experimental and control classes.

Table 4. Pretest Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	3,049	1	52	,087
	Based on Median	2,153	1	52	,148
	Based on Median and with adjusted df	2,153	1	49,215	,148
	Based on trimmed mean	2,844	1	52	,098

Based on Table 4, the homogeneity test result for the pretest shows that the calculated F-value was 3.049 with a significance value of 0.087. Since the significance value is greater than 0.05, it indicates that the variance of the pretest data between the experimental and control classes is homogeneous. This result suggests that before the treatment was given, both groups had similar data variability.

Results of the Post-Test Homogeneity Test of the Experimental and Control Classes

In this study, the homogeneity test was used to analyze the posttest results of creative thinking skills in both the experimental and control classes.

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Table 5. Posttest Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	,198	1	52	,658
	Based on Median	,122	1	52	,728
	Based on Median and with adjusted df	,122	1	51,083	,728
	Based on trimmed mean	,164	1	52	,687

Based on Table 5, the posttest homogeneity test results show that the calculated F-value was 0.198 with a significance value of 0.658. Since the significance value is greater than 0.05, it can be concluded that the variance of the posttest data between the experimental and control classes is homogeneous.

Homogeneity Test Results of Self-Assessment Before Treatment of Experimental Class and Control Class

In this study, the homogeneity test was used to analyze the self-assessment results before treatment on creative thinking skills in both the experimental and control classes.

Table 6. Homogeneity Test Results of Self-Assessment Before Treatment

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	,129	1	52	,719
	Based on Median	,106	1	52	,747
	Based on Median and with adjusted df	,106	1	50,324	,747
	Based on trimmed mean	,068	1	52	,796

Based on Table 6, the homogeneity test results for the pretest showed that the calculated F-value was 0.129 with a significance value of 0.719. Since the significance value is greater than 0.05, it indicates that the variance of the self-assessment data before treatment between the experimental and control classes is homogeneous. This result shows that, prior to the treatment, both groups had a similar level of data variability, allowing the conclusion that the initial conditions of students in both classes were relatively equivalent.

Homogeneity Test Results of Self-Assessment After Experimental Class and Control Class Treatment

In this study, the homogeneity test was used to analyze the self-assessment results after the treatment of creative thinking skills in both the experimental and control classes.

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Table 7. Homogeneity Test Results of Self-Assessment After Treatment

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Results	Based on Mean	3,528	1	52	,066
	Based on Median	3,358	1	52	,073
	Based on Median and with adjusted df	3,358	1	50,991	,073
	Based on trimmed mean	3,547	1	52	,065

Based on Table 7, the results of the homogeneity test showed that the calculated F-value was 3.528 with a significance value of 0.066. Since the significance value is greater than 0.05, it can be concluded that the variance of the self-assessment data after the treatment between the experimental and control classes is homogeneous. This result indicates that both groups had a similar level of data variability after the treatment, thus it can be concluded that the initial conditions of students in both classes were relatively equivalent.

Paired Sample T-Test Results Pretest-Posttest Experimental Class

In this analysis, the Paired Sample T-test was conducted to evaluate the pretest and posttest results in the experimental class. This test aimed to determine whether there was a significant change after the treatment was given.

Table 8. Paired Sample T-test Results for Pretest and Posttest of Experimental Class

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Eror Mean	95% Confidence Interval of the Difference		t	df	Sig.(2-tailed)
					Lower	Upper			
Pair 1	Pretes - Postes	-56,29630	13,55846	2,60933	-61,65985	-50,93275	-21,575	26	,000

Based on the results presented in Table 8, the Sig. (2-tailed) value was 0.000. Since the Sig. (2-tailed) value is less than 0.05 (0.000 < 0.05), it can be concluded that there is a significant difference in the average creative thinking skills of students due to the use of learning tools. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted. This means that the learning tools used are effective in improving students' creative thinking skills in physics learning.

Paired Sample T-Test Results Pretest-Posttest Control Class

In this analysis, the Paired Sample T-test was used to measure the difference between the pretest and posttest results in the control class. The test results are presented in Table 9.

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Table 9. Paired Sample T-test Results for Pretest and Posttest of Control Class

Paired Samples Test									
		Paired Differences							
		Mean	Std. Deviation	Std. Eror Mean	95% Confidence Interval of the Difference				
					Lower	Upper	t	df	Sig.(2-tailed)
Pair 1	Pretes - Postes	-16,74074	15,79579	3,03990	-22,98935	-10,49214	-5,507	26	,000

Based on the Paired Sample T-test results shown in the table, the Sig. (2-tailed) value was 0.000. Since this value is less than 0.05 (0.000 < 0.05), it can be concluded that there is a significant difference in the average creative thinking skills of students before and after the treatment. This indicates that the use of learning tools has a positive impact on improving creative thinking skills. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted, meaning that there is a significant difference between the pretest and posttest in the control class.

Paired Sample T-Test Results of Self-Assessment Before and After Experimental Class Treatment

In this study, the Paired Sample T-test was applied to analyze the self-assessment results before and after the treatment in the experimental class. The results are presented in Table 10.

Table 10. Paired Sample T-test Results of Self-Assessment Before and After Experimental Class Treatment

Paired Samples Test									
		Paired Differences							
		Mean	Std. Deviation	Std. Eror Mean	95% Confidence Interval of the Difference				
					Lower	Upper	t	df	Sig.(2-tailed)
Pair 1	Pretes - Postes	-18,37037	10,22496	1,96779	-22,41523	-14,32551	-9,336	26	,000

Based on the Paired Sample T-test shown in the table, the Sig. (2-tailed) value obtained was 0.000. Since this value is less than 0.05 (0.000 < 0.05), it can be concluded that there is a significant difference in the average creative thinking skills of students after the use of the learning tools. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted. This result indicates that the learning tools used are effective in enhancing students' creative thinking skills in physics learning.

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Paired Sample T-Test Results of Self-Assessment Before and After Control Class Treatment

In this study, the Paired Sample T-test was used to evaluate the self-assessment results before and after the treatment in the control class. The results are presented in Table 11.

Table 11. Paired Sample T-test Results of Self-Assessment Before and After Control Class Treatment

Paired Samples Test

		Paired Differences							
		Mean	Std. Deviation	Std. Eror Mean	95% Confidence Interval of the Difference		t	df	Sig.(2-tailed)
					Lower	Upper			
Pair 1	Pretes-Postes	-10,03704	9,38690	1,80651	-13,75037	-6,32370	-5,556	26	,000

Based on the Paired Sample T-test, the Sig. (2-tailed) value obtained was 0.000. Since this value is less than 0.05 ($0.000 < 0.05$), it can be concluded that there is a significant difference in the average creative thinking skills of students before and after the treatment. This indicates that the use of learning tools has a positive impact on improving creative thinking skills. Therefore, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_a) is accepted.

Discussion

The planning stage marks the beginning of the research process, during which the researcher prepares all the necessary tools. It begins with conducting observations at the school to understand students' creative thinking skills, primarily through interviews and direct classroom observation. According to an interview with a physics teacher on October 23, 2024, the teacher expressed difficulty in creating engaging physics lessons that captured students' interest, particularly regarding the topic of rotational dynamics. This was identified as a challenging area that led to student reluctance to participate in class. The teacher relied heavily on direct lecture methods, without incorporating problem-based learning (PBL). A follow-up visit on November 6, 2024, revealed that the lack of local wisdom integration in the lessons further decreased students' interest. Consequently, students exhibited low creative thinking skills, and their behavior during lessons included drowsiness and off-topic conversations. Upon identifying the challenges in the physics learning environment, the researcher prepared a creative thinking skills questionnaire to gain a clearer understanding of students' abilities. The researcher also designed several learning tools, including a teaching module, student worksheets (LKPD), presentation assessment sheets, observation sheets for evaluating students' creative thinking skills, and a traditional spinning top (Gasingan) as a teaching aid reflecting local wisdom.

The next stage of the research involved administering a pretest and self-assessment before the treatment. This phase took place prior to the first learning session, where students were given 30 minutes to answer independently. The pretest and self-assessment results were used to assess students' initial creative thinking skills, which would later be compared to post-test results to measure improvement.

The treatment phase involved two classes: an experimental class and a control class. Both classes underwent three meetings during the learning process to observe improvements in students' creative thinking skills. The learning was carried out step-by-step, following the PBL syntax. Each meeting in both classes consisted of preliminary, core, and closing activities. In the experimental class, the Problem-Based Learning (PBL) model was integrated with STEM and local wisdom through the Gasingan game. Students were presented with problems related to physics concepts, particularly those associated with the Gasingan game, to enhance their creative thinking skills by linking theory with real-world practice. On the other hand, the control class utilized PBL without integrating STEM and local wisdom, focusing solely on theoretical problem-solving without exploring the practical application of concepts.

Both classes started with similar preliminary activities, including greetings, attendance, and preparation for the main learning activities. In the experimental class, students demonstrated higher levels of engagement, although some remained less involved. The control class, on the other hand, exhibited more passive participation from most students. Throughout the study, the researcher encountered different challenges based on the learning approach used. In the experimental class, students were more active but required structured group tasks to maintain focus and engagement. Rewards were provided to encourage participation. In the control class, students were mostly passive, with only a few showing enthusiasm. The researcher had to encourage participation from less active students by assigning individual tasks within group work. The study highlighted the need for tailored approaches to learning, with active classes requiring more structured guidance and passive classes needing extra motivation. Overall, both classes demonstrated improvement in creative thinking skills.

The final stage of the research involved administering the post-test and self-assessment after the treatment. This phase took place during the third meeting, where students were given 30 minutes to complete the post-test independently. The post-test results reflected the students' final creative thinking skills, and these results were compared to the pre-test data to determine any improvements. This is relevant to the research conducted by Astuti (2021), which explains that by integrating physics learning with traditional games, it is expected to become a learning resource and teaching material for physics, making it easier for students to learn physics and enabling them to understand the subject matter well. The implementation of this learning approach can also help develop and preserve local wisdom objects and the cultures that have been established.

Conclusion

The implementation of STEM-integrated Problem-Based Learning (PBL) instructional materials based on local wisdom in the topic of rotational dynamics proved to be effective in enhancing students' creative thinking skills at SMA Negeri 11 Kota Jambi. This was demonstrated through statistical tests conducted using both SPSS and manual calculations with Microsoft Excel. The significance value from the Paired Sample T-test indicated a significant difference between the pre-test and post-test data, as well as between the self-assessment results before and after the treatment in the experimental class. Compared to the control class, the improvement in creative thinking skills in the experimental class was higher, indicating that the use of these instructional materials had a positive impact on the physics learning process, particularly on the topic of rotational dynamics.

Recommendation

Future research is encouraged to develop STEM-integrated PBL learning devices based on other forms of local wisdom beyond Gasingan, and apply them to various science topics to enhance creative thinking skills. It is also recommended to conduct studies across different school levels and regions to examine broader applicability. Some barriers encountered during this research include limited student engagement, especially in passive learning environments, and constraints related to time and learning resources. Future studies should anticipate these challenges by preparing adequate materials, optimizing lesson duration, and training teachers to implement the model more effectively.

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