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IMPLEMENTATION OF STEM-INTEGRATED PBL LEARNING TOOLS BASED ON LOCAL WISDOM (GENDANG MELAYU) TO IMPROVE STUDENTS' CRITICAL THINKING SKILLS

Wina Tiodora Br Sinuraya[*1], Haerul Pathoni [2], Jeliana Veronika Sirait [3]
[1,2,3)] Physics Education, Teacher Training and Education Faculty, Jambi University
[*]*Corresponding author*
e-mail: winatiodora@gmail.com[1], haerul_pathoni@unja.ac.id[2], jelianasirait@unja.ac.id [3]

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ABSTRAK

This study aims to investigate the impact of STEM-integrated PBL learning tools based on local wisdom (Gendang Melayu) on students' critical thinking skills and compare the improvement in critical thinking abilities between classes that implemented these tools and those that did not. The study employed a quasi-experimental design with a Non-Equivalent Pretest-Posttest Control Group Design among 11th-grade students at SMA Adhyaksa I Jambi. The results of the study showed that there was an increase in students' critical thinking skills through the implementation of integrated STEM PBL learning devices based on local wisdom (Gendang Melayu) on sound wave material at SMA Adhyaksa I Jambi in the experimental class with a sig value (2 tailed) of 0.000 on critical thinking skills questions. Furthermore, there was a significant difference in the increase in students' critical thinking skills between classes that received the implementation of integrated STEM PBL learning devices based on local wisdom (Gendang Melayu) and classes that did not, with a Sig value. (2-tailed) of 0.001 on critical thinking skills questions.This research offers a unique contribution by merging PBL and STEM with the cultural heritage of Gendang Melayu Jambi in physics learning, strengthening the link between scientific knowledge and local culture.

***Keywords*:** PBL; STEM; gendang melayu; critical thinking

INTRODUCTION

Physics is a branch of science that explores natural phenomena through facts, principles, and laws validated by the scientific method (Syahrial *et al*., 2022). It is not merely a collection of theories and formulas to be memorized, but a discipline that requires a deep understanding of the underlying processes. This perspective aligns with the view of (Mahardika *et al*., 2021), which emphasizes that physics learning prioritizes deep conceptual understanding, where knowledge is constructed through discovery processes. Therefore, physics demands comprehensive understanding and the ability to apply concepts in problem-solving, making learning not only theoretical but also practical and contextual.

Many students consider physics a daunting. They frequently perceive physics as complex and difficult to comprehend, making it one of the less popular subjects among students (Arifah *et al*., 2021). Research has shown that physics is considered a challenging subject by many learners (Nurjanah & Sunarto, 2018). Specifically, topics like sound waves are particularly troublesome for students (Nurdiansah *et al*., 2020), largely due to the deep conceptual understanding required to grasp them(Nurrohmah & Rahayu, 2022).

One reason students often struggle with physics, especially sound waves, is their difficulty in understanding the

underlying concepts (Amalissholeh *et al*., 2023). Conceptual understanding is crucial in physics, as it enables students to apply principles in real-life situations (Rizkita & Mufit, 2022). Unfortunately, this highlights a gap in achieving the objectives of physics education as outlined in the Ministry of National Education Regulation (Permendiknas) No. 22 of 2006, which aims to equip students with mastery of physics knowledge, concepts, and principles, as well as develop scientific skills and attitudes (Permendiknas, 2006).

Developing a solid understanding of physics concepts requires students to possess critical thinking skills (Erwina Oktavianty, 2017). Critical thinking enables students to solve problems by linking various concepts and prior knowledge to make informed and logical decisions (Putri Dwi Sundari1*, 2022). By applying critical thinking, students can analyze and evaluate physics concepts, recognize the connection between theory and practice, and devise solutions based on logic and evidence (Suparmin, 2019).

To improve students' critical thinking skills, learning tools that are relevant and contextual are necessary. The Merdeka Curriculum's teaching modules offer flexibility for teachers to design lessons that cater to students' needs and characteristics (Faridahtul Jannah & Thooriq Irtifa' Fathuddi, 2023). Effective learning tools enable teachers to plan lessons tailored to students' profiles, which can enhance critical thinking skills when combined with suitable approaches and instructional models (Istiqah *et al*., 2021). One effective model for achieving this is Problem-Based Learning (PBL), which has been shown to support critical thinking development (Aripin *et al*., 2021).

Problem-Based Learning (PBL) is an instructional model that involves solving real-world problems, prompting students to apply critical thinking skills to find solutions (Halimah *et al*., 2023). PBL is effective in developing critical thinking skills because it facilitates learning in a natural and meaningful context. By engaging in authentic situations related to the subject matter, students can participate actively and directly, which enhances their understanding of concepts and fosters critical thinking (Faudziah & Budiman, 2023).

To develop critical thinking skills, it is essential to integrate disciplines relevant to the current industrial revolution era, such as STEM (Science, Technology, Engineering, and Mathematics). STEM is an instructional approach that combines multiple disciplines, enabling students to acquire both knowledge and skills simultaneously (Wahyuni & Tri Lestari, 2022). This approach goes beyond merely merging four fields of study; it also involves innovation and applied processes to design solutions to real-world problems (Zakiyah R *et al*., 2023). Through STEM-based learning, students gain comprehensive knowledge and develop skills to tackle real-life challenges, which in turn enhances their critical thinking abilities (Faizah *et al*., 2022).

Integrating local wisdom into physics learning can enhance students' understanding of concepts, enable them to apply these concepts in real-life situations, and develop critical thinking skills a key competency in the Merdeka Curriculum. By linking learning materials to local wisdom, students can more easily and quickly grasp concepts (Azizah & Astuti, 2020). When the subject matter is connected to local culture, students are

more likely to understand the concepts being taught, as they can see the direct relevance to their daily lives (Ahmadi *et al*., 2019).

Based on the results of interviews conducted, it was found that physics teachers at SMA Adhyaksa I Jambi have not yet utilized instructional tools with relevant approaches that support the development of students' critical thinking skills. As a result, students' critical thinking abilities remain low, as reflected in their generally low scores, particularly on the topic of sound waves. The interviews also revealed that physics teachers at SMA Adhyaksa I Jambi have not integrated local wisdom into their teaching practices. This is supported by the results of a preliminary perception test administered to students of classes XI F.K1A and F.K1B, which showed that their knowledge of Jambi's local wisdom—specifically Gendang Melayu and their understanding of physics concepts related to this local content were still very limited. In fact, Gendang Melayu is one of Jambi's cultural heritages that not only holds high cultural value but is also closely related to physical phenomena, namely sound waves. The sounds produced by the Gendang Melayu are a direct representation of the concept of sound waves. By utilizing Gendang Melayu as a learning medium, students can more easily understand these concepts in a contextual and applicable manner.

To address the challenges faced by students at SMA Adhyaksa I Jambi, a proposed solution is to develop a Problem-Based Learning (PBL) instructional package that integrates STEM and local wisdom (Gendang Melayu) to enhance critical thinking skills on the topic of sound waves. Previous research has demonstrated that PBL combined with STEM can significantly improve critical thinking skills, with studies showing a significant effect ($p < 0.05$) (Zakiyah R *et al*., 2023). Other studies have also reported positive outcomes from implementing PBL integrated with STEM, highlighting its effectiveness in developing students' critical thinking abilities (Ariyatun & Octavianelis, 2020),(Khoirunnissa *et al*., 2024), (Khoiriyah *et al*., 2018), (Wahdaniyah *et al*., 2023),(Setia Permana *et al*., 2021) .

Although Problem-Based Learning (PBL), STEM, and local wisdom have each been shown to be effective in enhancing students' critical thinking skills individually, no research has yet combined these three elements into a single instructional package. This highlights the need for a study that integrates PBL, STEM, and local wisdom into a unified framework to improve students' critical thinking skills. The combination of these components represents a novelty in this research. Through this approach, students will not only learn theoretical concepts but also engage directly in real-life situations relevant to the subject matter, enabling them to better understand the concepts and develop their critical thinking abilities.

METHOD

This study employs a comparative quantitative research design, utilizing a quasi-experimental method with a non-equivalent pretest-posttest control group design. Both the experimental and control groups undergo pretesting before treatment and posttesting after treatment completion (Isnawan *et al*., 2020). The experimental group receives instruction through a PBL-STEM integrated learning package incorporating Gendang Melayu, whereas the control group is taught using PBL

without STEM and Gendang Melayu integration.

This research was carried out at SMA Adhyaksa I Jambi from September 2024 to March 2025, driven by the need to integrate local wisdom into physics education. The school's current curriculum lacks this integration, making it an ideal setting for testing a Gendang Melayu-based learning package aimed at enhancing students' grasp of sound waves. The study focused on eleventh-grade physics students in the 2024/2025 academic year. Two classes, XI FK1A and XI FK1B, were selected as the sample using total sampling, which included all students in both classes. This approach was chosen due to the manageable population size, enabling a more precise evaluation of the learning package's effectiveness.

The research was carried out in three main stages, namely the preparation stage, the implementation stage, and the follow-up stage, with the following details :

1. The preparation stage involved several key steps. First, a preliminary study was conducted through interviews with a physics teacher at SMA Adhyaksa I Jambi to gather insights into the teaching methods and challenges in physics education. An initial perception test was also administered to students to assess their understanding of the connection between local wisdom (Gendang Melayu) and physics concepts. Based on the findings, a teaching module was developed in line with the Merdeka Curriculum, integrating Problem-Based Learning (PBL) with STEM and local wisdom. The module underwent expert validation to ensure its feasibility before being implemented in the study. Any identified shortcomings were addressed through revisions based on feedback from academic supervisors.
2. The implementation stage commenced with a pretest administered to both the experimental and control groups, comprising a critical thinking skills test. This aimed to evaluate the students' initial critical thinking levels and ensure equivalency between the groups. Subsequently, teaching sessions were conducted with distinct approaches: the experimental class utilized a PBL module integrating STEM and Gendang Melayu, while the control class employed a standard PBL model. Upon completion of the teaching sessions, a posttest was administered to measure the improvement in students' critical thinking skills.
3. The follow-up stage involved processing data from the validation of learning materials by expert validators. The research results, including pretest and posttest data, were then analyzed using statistical tests to assess the effectiveness of the learning module. Finally, the findings were discussed, and conclusions were drawn based on the data analysis, providing insight into the impact of the learning device on students' critical thinking skills.

Prior to data collection, the research instruments underwent validation to ensure their validity and reliability in measuring the study's variables. The validation process encompassed the teaching module and student worksheets (LKPD).

1. Teaching Module, the teaching module for the experimental class was developed using Problem-Based Learning (PBL) integrated with STEM and local wisdom (Gendang Melayu) to

improve students' critical thinking skills. In contrast, the control class module was based solely on PBL. A validation sheet blueprint was created to assess the module's effectiveness.

Table 1. Blueprint of the Teaching Module Validation Sheet.

No.	Indicator	Statement Item	Statement Number
GENERAL INFORMATION			
1.	Module Identity	1	1
2.	Initial Competency	1	2
3.	Pancasila Student Profile	1	3
4.	Facilities and Infrastructure	2	4,5
5.	Target Students	3	6,7,8
6.	Learning Model	1	9
7.	Completeness of Teaching Materials	3	10,11,12
CORE COMPONENTS			
1.	Learning Objectives	2	1,2
2.	Meaningful Understanding	1	3
3.	Trigger Questions	1	4
4.	Learning Activities	4	5,6,7,8
5.	Assesment	7	9,10,11,12,13
6.	Enrichment and Remedial Questions	2	14,15
7.	Teacher and Student Reflection	2	16,17
8.	Glossary	1	18
9.	References	1	19
ATTACHMENTS			
1.	Student Worksheet or Assignment Sheet	1	1
2.	Teaching Material	1	2

(Fitrianti Lubis, 2024)

2. LKPD, The validation of the Student Worksheet (LKPD) aims to ensure that the designed worksheets meet quality standards and align with the learning objectives. The LKPD for the experimental class integrates STEM and is based on local wisdom (Gendang Melayu), adapted from thesis Muhammad Musyaddad, 2024. Meanwhile, the LKPD for the control class was developed based on a sound wave experiment. The outline is :

Table 2. Blueprint of the LKPD Validation Sheet

No.	Indicator	Statement Item	Statement Number
1.	Format	3	1,2,3
2.	Language	5	4,5,6,7,8
3.	Content	4	9,10,11,12

(Fitrianti Lubis, 2024)

The rating scale on the validation sheet uses a Likert scale with the following score range.

Table 3. Rating Scale

Score	Category
1	Strongly Agree
2	Agree
3	Disagree
4	Strongly Disagree

The data obtained from the validation questionnaires of the teaching module, student worksheet (LKPD), self-assessment questionnaire, and observation sheet on critical thinking skills will be calculated using the following formula :

$$\text{Percentage} = \frac{\text{Total Score}}{\text{Maximum Score}} \times 100\ \%$$

Furthermore, the data will be interpreted into a conclusion categorized criteria. The criteria table is presented as follows :

Table 4. Assessment Criteria

Percentage	Criteria
$85\% < x$	Highly Feasible
$70\% < x \leq 85\%$	Feasible
$55\% < x \leq 70\%$	Fairly Feasible
$40\% < x \leq 55\%$	Less Feasible
$x < 40\%$	Not Feasible

(Rahmawati & Fajriyah, 2022)

After the research instruments are validated, the next step is data collection to analyze the effect of the treatment given. The data collection instruments used in this study consist of several measurement tools designed to obtain data systematically and validly. These include multiple-choice reasoning questions on critical thinking skills based on the concept of sound waves.

1. The critical thinking skills test instrument on the topic of sound waves was adapted from the thesis by Haq, which had previously undergone tests for reliability, discrimination index, difficulty index, and consistency analysis (Haq, 2023). The original test consisted of 20 items and was trialed on 70 students, resulting in 15 valid items and 5 invalid ones. Of the 15 valid items, 9 were related to sound waves and 6 to standing traveling waves. Since this study focuses on sound waves, only the 9 relevant items were adopted. The table below presents the test blueprint for critical thinking skills.

Table 5. Critical Thinking Skills Test Blueprint

Indicator	Dimensions of Critical Thinking Skills					Jumlah Soal
	A	B	C	D	E	
Analyze the characteristics of sound waves	8	2				2
Analyze the speed of sound wave propagation			3	7		2
Analyze Doppler effect		4				1
Analyze string and organ pipe phenomena	1	6				2
Analyze intensity and sound level			5		9	2
Total	2	3	2	1	1	9

(Haq, 2023)

Note :
A = Providing simple explanations
B = Building basic skills
C = Drawing conclusions
D = Making further explanations
E = Strategizing and applying tactics

The collected data were statistically analyzed using IBM SPSS 20 software to determine the effectiveness of the implemented instructional tools. The statistical tests used in this study included:

1. Normality Test, a normality test was conducted to determine whether the data were normally distributed, a prerequisite for performing parametric tests (Sari *et al*., 2024). The Kolmogorov-Smirnov test was used since the sample size was greater than 50. The decision criteria were: if the significance value is greater than 0.05, the data are considered normally distributed; if the significance value is less than 0.05, the data are not normally distributed.
2. The homogeneity test was conducted to determine if the variances between the two groups were homogeneous (Usmadi, 2020). The test used was the two-variance homogeneity test, with the following hypotheses:
   H_0 : There is homogeneity of variance in students' critical thinking test scores
   H_1 : There is no homogeneity of variance in students' critical thinking test scores.
3. T-Test, the t-test is a statistical method for comparing the means of two groups or samples, measuring the significance of the difference between them (Mayang Marisya, 2019). It's used to examine the influence of independent variables on the dependent variable. This study employed two types of t-tests: Independent Samples t-Test and Paired Samples t-Test.
   a *Paired Sample T-test*
   This test assessed the improvement in students' critical thinking skills before and after the learning intervention. The decision rule was to accept H_1 if the probability value (Asymp. Sig) was less than 0.05 (Muhid, 2019). The hypotheses were:
   H_0 : No significant improvement in critical thinking skills after using PBL-STEM learning tools based on local wisdom (Gendang Melayu).
   H_1 : Significant improvement in critical thinking skills after using PBL-STEM learning tools based on local wisdom (Gendang Melayu).
   b *Independent Sample t Test*
   Data analysis compared pretest and posttest results between the control and experimental classes to assess treatment effectiveness. The Independent Samples t-Test examined whether a significant difference existed between the mean scores of two unrelated groups (Nuryadi *et al*., 2017). The Independent Samples t-Test was used to compare the mean scores between two unrelated groups. The hypotheses were:
   H_0 : No significant difference in mean critical thinking skills between students taught with PBL-STEM based on local wisdom (Gendang Melayu) and those without.
   H_1 : Significant difference in mean critical thinking skills between students taught with PBL-STEM based on local wisdom (Gendang Melayu) and those without.

RESULTS AND DISCUSSION

A. Product Validation

1. Validation of the Experimental Class Teaching Module

The validation results from Validator 1 for the PBL-STEM teaching module incorporating local wisdom (Gendang

Melayu) on sound waves are outlined in the table below.

Table 6. Validation Percentage Results by Validator 1

No.	Research Aspect	Percentage	Category
1	General Information	100 %	Highly Feasible
2	Core Components	100 %	Highly Feasible
3	Attachments	100 %	Highly Feasible
	Average	100 %	Highly Feasible

The results show that the validation of the PBL teaching module integrated with STEM and based on local wisdom (*Gendang Melayu*) in the sound waves topic by Validator 1 obtained an average score of 100%, categorized as "Highly Feasible".

The validation results from Validator 2 for the PBL-STEM teaching module based on local wisdom (Gendang Melayu) are shown in the table below.

Table 7. Validation Percentage Results by Validator 2

No.	Research Aspect	Percentage	Category
1	General Information	100 %	Highly Feasible
2	Core Components	94,78 %	Highly Feasible
3	Attachments	100 %	Highly Feasible
	Average	98,26%	Highly Feasible

The results indicate that the teaching module received an average score of 98.26% from Validator 2, categorized as "Highly Feasible". The detailed scores for each aspect are: 100% for general information, 94.78% for core components, and 100% for attachments.

2. Validation Of The Control Class Teaching Module

The validation results from Validator 1 for the PBL teaching module on sound waves are outlined in the table below.

Table 8. Validation Percentage Results by Validator 1

No.	Research Aspect	Percentage	Category
1	General Information	100%	Highly Feasible
2	Core Components	100%	Highly Feasible
3	Attachments	100%	Highly Feasible
	Average	100%	Highly Feasible

The validation results indicate that the PBL teaching module in the sound waves topic, as assessed by Validator 1, received an average score of 100%, categorized as "Highly Feasible".

The validation results by Validator 2 for the same teaching module are presented in the following table.

Table 9. Validation Percentage Results by Validator 2

No.	Research Aspect	Percentage	Category
1	General Information	100 %	Highly Feasible
2	Core Components	94,73 %	Highly Feasible
3	Attachments	100 %	Highly Feasible
	Average	98,24%	Highly Feasible

These results indicate that the PBL teaching module in the sound waves topic, validated by Validator 2, obtained an average feasibility score of 98.24%, categorized as "Highly Feasible".

3. Validation Of LKPD For The Experimental Class

The validation results by Validator 1 on the development of the STEM-based LKPD incorporating local wisdom

(Gendang Melayu) for the sound waves topic are presented in the following table:

Table 10. Validation Percentage Results by Validator 1

No.	Research Aspect	Percentage	Category
1	Format	100 %	Highly Feasible
2	Language	100 %	Highly Feasible
3	Content	100 %	Highly Feasible
Average		100 %	Highly Feasible

The results show that the STEM-based LKPD integrating local wisdom (Gendang Melayu) on the sound waves topic received an average score of 100% from Validator 1, categorized as "Highly Feasible".

The validation results from Validator 2 are outlined in the table below.

Table 11. Validation Percentage Results by Validator 2

No.	Research Aspect	Percentage	Category
1	Format	100 %	Highly Feasible
2	Language	80 %	Feasible
3	Content	100 %	Highly Feasible
Average		93,33%	Highly Feasible

The results show that the STEM-based LKPD integrating local wisdom (Gendang Melayu) on the sound waves topic received an average score of 93.33% from Validator 2, categorized as "Highly Feasible".

4. Validation Of LKPD For The Control Class

Validator 1's assessment results for the LKPD on sound waves are presented in the following table.

Table 12. Validation Percentage Results by Validator 1

No.	Research Aspect	Percentage	Category
1	Format	100 %	Highly Feasible
2	Language	100 %	Highly Feasible
3	Content	100 %	Highly Feasible
Average		100 %	Highly Feasible

The results show that the LKPD for the sound waves topic received an average score of 100% from Validator 1, categorized as "Highly Feasible".

Validator 2's assessment results are presented in the following table.

Table 13. Validation Percentage Results by Validator 2

No.	Research Aspect	Percentage	Category
1	Format	100 %	Highly Feasible
2	Language	80 %	Feasible
3	Content	100 %	Highly Feasible
Average		93,33 %	Highly Feasible

These results show that the LKPD for the sound waves topic received an average score of 93.33% from Validator 2, categorized as "Highly Feasible".

B. Data Acquisition

1. Students' Pretest and Posttest Results

The study's findings showed that before the treatment, the experimental class had a lower average pretest score 41.98 compared to the control class 44.65, indicating low critical thinking skills in both classes. After the treatment, both classes showed significant improvement, with the experimental class scoring higher 79.42 than the control class 70.58. Notably, the experimental class, which initially scored lower, surpassed the control class in

the posttest. The experimental class saw a 37.44 point increase, compared to a 25.93 point increase in the control class. This suggests that the STEM-integrated PBL learning tools based on local wisdom (Gendang Melayu) had a more significant impact on improving critical thinking skills than the control class's teaching methods.

C. Data Analysis

1. Normality Test

a. Pretest and Posttest Results on Critical Thinking Skills

Normality tests were conducted on pretest and posttest data for critical thinking skills in experimental and control classes, and the results are presented in the following table.

Table 14. Normality Test Results of Critical Thinking Skills Test

Tests of Normality				
		Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
Results	Pretest (Experimental Class)	.147	27	.139
	Posttest (Experimental Class)	.161	27	.069
	Pretest (Control Class)	.123	27	.200*
	Posttest (Control Class)	.165	27	.057

The normality test results showed significance values above 0.05 for all groups: experimental class pretest 0.139 and posttest 0.069, and control class pretest 0.200 and posttest 0.057. Since all values exceeded 0.05, the data is normally distributed, meeting the normality assumption.

2. Homogeneity Test

a. Pretest Results of the Critical Thinking Skills Test

The homogeneity test was performed on the pretest results of the critical thinking skills test for both experimental and control classes, with results shown in the table below.

Table 15. Homogeneity Test Results of the Pretest on Critical Thinking Skills

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Pretest Score	Based on Mean	.212	1	52	.647
	Based on Median	.219	1	52	.642
	Based on Median and with adjusted df	.219	1	51.999	.642
	Based on trimmed mean	.212	1	52	.647

The homogeneity test results showed a significance value of 0.647, which is greater than 0.05, indicating that the variance of the pretest data between the experimental and control classes is homogeneous.

b. Posttest Results of the Critical Thinking Skills Test

The homogeneity test was performed on the posttest results of the critical thinking skills test for both experimental and control classes, with results shown in the table below.

Table 16. Homogeneity Test Results of the Posttest on Critical Thinking Skills

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Posttest Score	Based on Mean	.205	1	52	.653
	Based on Median	.234	1	52	.630

	Based on Median and with adjusted df	.234	1	51.739	.630
	Based on trimmed mean	.187	1	52	.668
	Based on trimmed mean	.212	1	52	.647

The homogeneity test results showed a significance value of 0.653, which is greater than 0.05, indicating that the posttest data variances between the experimental and control classes are homogeneous.

3. Paired Samples T-Test

a. Results of Critical Thinking Skills Test in the Experimental Class

The Paired Samples T-Test was used to determine if there's a significant difference in students' critical thinking skills before and after implementing STEM-integrated PBL learning tools based on Jambi's local wisdom (Gendang Melayu) on sound waves.

Table 17. Paired Samples T-Test Results of Pretest and Posttest Critical Thinking Skills Test in the Experimental Class

Paired Samples Test								
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest-Posttest	-37.44778	13.12811	2.52650	-42.64108	-32.25447	-14.822	26	.000

The Paired Samples T-Test results showed a significance value of 0.000, which is less than 0.05, indicating a significant difference between pretest and posttest scores in the experimental class. This suggests that the STEM-integrated PBL learning tools based on Jambi's local wisdom (Gendang Melayu) significantly improved students' critical thinking skills.

b. Results of Critical Thinking Skills Test in the Control Class

The Paired Samples T-Test was used to determine if there's a significant difference in students' critical thinking skills before and after implementing the PBL learning model on sound waves.

Table 18. Paired Samples T-Test Results of Pretest and Posttest Critical Thinking Skills Test in the Control Class

Paired Samples Test								
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pretest-Posttest	-25.92519	12.98326	2.49863	-31.06119	-20.78918	-10.376	26	.000

The Paired Samples T-Test results showed a significance value of 0.000, which is less than 0.05, indicating a significant difference between pretest and posttest scores in the control class. This suggests that the PBL learning model effectively improved students' critical thinking skills on sound waves.

4. Independent Sample T-Test

a. Pretest Results of Critical Thinking Skills Test

The Independent Sample T-Test was used to compare the pretest scores of critical thinking skills between the experimental and control groups before treatment, with results presented below.

Table 19. Independent Sample T-Test Results of Pretest Critical Thinking Skills

		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
Pretest	Equal variances assumed	.212	.647	-.725	52	.472	-2.67481	3.68965	-10.07865	4.72902
	Equal variances not assumed			-.725	51.681	.472	-2.67481	3.68965	-10.07973	4.73011

The Independent Sample T-Test results showed a Sig. (2-tailed) value of 0.472, which is greater than 0.05, indicating no significant difference in pretest critical thinking scores between the experimental and control groups. This suggests that both groups had relatively equal critical thinking skills before the treatment.

b. Posttest Results Of Critical Thinking Skills Questions

The Independent Sample T-Test was used to compare posttest critical thinking scores betwen the experimental and control groups after the intervention.

Table 20. Results of Independent Sample T-Test on Posttest – Critical Thinking Skills Questions

		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
Posttest	Equal variances assumed	.205	.653	3.365	52	.001	8.84778	2.62915	3.57201	14.12355
	Equal variances not assumed			3.365	51.925	.001	8.84778	2.62915	3.57182	14.12373

The Independent Sample T-Test results showed a Sig. (2-tailed) value of 0.001, which is less than 0.05, indicating a significant difference in posttest critical thinking scores between the experimental and control groups. This suggests that the treatment had a significant impact on improving students' critical thinking skills.

CONCLUSION

The results of the study showed that there was an increase in students' critical thinking skills through the implementation of integrated STEM PBL learning devices based on local wisdom (Gendang Melayu) on sound wave material at SMA Adhyaksa I Jambi in the experimental class with a sig value (2 tailed) of 0.000 on critical thinking skills questions. Furthermore, there was a significant difference in the increase in students' critical thinking skills between the class that received the implementation of integrated STEM PBL learning devices based on local wisdom (Gendang Melayu) and the class that did not, with a Sig value. (2-tailed) of 0.001 on critical thinking skills questions, which means that there was a significant difference between the final scores of the experimental group and the control group after being given treatment. The experimental class showed a higher increase in critical thinking skills compared to the control class, which shows the effectiveness of this learning approach. This learning package improves the quality of physics learning and supports the achievement of critical thinking competencies, in line with the objectives of the Merdeka Curriculum. Furthermore, this study opens up opportunities for further development and innovation in other subjects and levels of education.

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