

INTEGRATION LOCAL WISDOM ON BONO WAVES IN SCIENCE EDUCATION TO IMPROVE SCIENCE LITERACY AND CULTURAL UNDERSTANDING OF ELEMENTARY SCHOOL STUDENTS

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Abstrak

Penelitian ini dilatarbelakangi oleh pentingnya mengintegrasikan nilai-nilai kearifan lokal ke dalam pembelajaran Ilmu Pengetahuan Alam (IPA), sehingga siswa tidak hanya menguasai konsep-konsep ilmiah, tetapi juga mengembangkan pemahaman terhadap warisan budaya mereka. Penelitian ini bertujuan untuk mengetahui efektivitas pembelajaran IPA berbasis integrasi kearifan lokal Gelombang Bono dalam meningkatkan literasi sains dan pemahaman budaya siswa. Penelitian ini menggunakan pendekatan kuantitatif dengan desain One Group Pretest–Posttest, yang melibatkan 21 siswa kelas V SDN 105 Pekanbaru. Instrumen penelitian terdiri atas tes literasi sains berbentuk pilihan ganda dan angket pemahaman budaya menggunakan skala Likert. Kedua instrumen tersebut telah melalui proses validasi dan uji reliabilitas. Data dianalisis menggunakan uji normalitas Shapiro–Wilk, uji paired sample t-test, dan analisis N-Gain untuk mengukur tingkat efektivitas pembelajaran. Hasil penelitian menunjukkan adanya perbedaan yang signifikan antara nilai pretest dan posttest, dengan nilai $t = -18,514$ (Sig. 0,000) untuk literasi sains dan $t = -16,850$ (Sig. 0,000) untuk pemahaman budaya. Nilai rata-rata N-Gain sebesar 0,565 menunjukkan tingkat efektivitas dalam kategori sedang, dengan peningkatan tertinggi pada literasi sains sebesar 0,798 (kategori tinggi) dan pemahaman budaya sebesar 0,332 (kategori sedang). Dapat disimpulkan bahwa integrasi kearifan lokal Gelombang Bono dalam pembelajaran IPA efektif dalam meningkatkan literasi sains dan pemahaman budaya siswa. Pendekatan ini juga berpotensi menjadi model pembelajaran kontekstual yang memperkuat karakter ilmiah dan nilai-nilai budaya dalam pendidikan sekolah dasar.

Kata kunci: gelombang bono, pemahaman budaya, kearifan lokal, pendidikan ipa, literasi sains.

Abstract

This study was motivated by the importance of integrating local wisdom values into science learning so that students not only master scientific concepts but also develop an understanding of their cultural heritage. The purpose of this research was to determine the effectiveness science learning based on the integration of the Bono wave local wisdom in improving students' scientific literacy and cultural understanding. The study employed a quantitative approach with a One Group Pretest–Posttest Design, involving 21 fifth-grade students from SDN 105 Pekanbaru. The research instruments consisted of a multiple-choice scientific literacy test and a Likert-scale cultural understanding questionnaire, both of which had been validated and tested for reliability. Data were analyzed using the Shapiro–Wilk normality test, paired sample t-test, and N-Gain analysis to assess the level of learning effectiveness. The results showed a significant difference between pretest and posttest scores, with $t = -18.514$ (Sig. 0.000) for scientific literacy and $t = -16.850$ (Sig. 0.000) for cultural understanding. The average N-Gain score of 0.565 indicated a moderate level of effectiveness, with the highest improvement in scientific literacy (0.798; high category) and cultural understanding (0.332; moderate category). It can be concluded that integrating Bono Wave local wisdom into Sciences learning is effective in enhancing students' scientific literacy and cultural understanding and has the potential to serve as a contextual learning model that strengthens scientific character and cultural values in elementary education.

Keywords: bono wave; cultural understanding; local wisdom; science education, science literacy

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1. Introduction

The learning of Natural Science plays a vital role in developing students' scientific literacy and preparing them to face the global challenges of the 21st century. However, its implementation in Indonesia remains predominantly conventional, emphasizing theoretical concept mastery without sufficient connection to real-life contexts. Research indicates that instructional models which do not involve local environments and cultures tend to make it difficult for students to grasp the relevance of science in everyday life (Rahayu et al., 2022). Another study found that the lack of cultural engagement in learning has a negative impact on students' scientific character formation (Wuwur et al., 2023). Furthermore, research emphasizes that integrating local cultural values into science learning can strengthen conceptual understanding and enhance students' learning motivation (Muin & Utami, 2024). A literature analysis reveals that this gap arises from instructional practices that fail to connect theoretical knowledge with the students' sociocultural contexts (Setiawan, 2024). Empirical studies further note that students still struggle to relate scientific concepts to environmental realities due to the limited implementation of locally based phenomenon learning (Irhasyuarna et al., 2022).

Contextual learning has been recognized as one of the approaches capable of bridging the gap between scientific knowledge and social reality. Studies have shown that the implementation of context-based learning enhances students' conceptual understanding and critical thinking skills (Ambarwati et al., 2025). Experimental research has also demonstrated that integrating local cultural values into science education positively affects students' learning outcomes and scientific literacy (Fauzi et al., 2022). Moreover, research on the development of culture-based teaching materials indicates that this approach strengthens students' analytical abilities in understanding natural phenomena in an applied manner (Santika et al., 2023). The integration of local wisdom in science learning not only deepens conceptual understanding but also instills social character and cultural identity. Studies reveal that the use of the Bundengan musical instrument in physics learning can increase scientific literacy by up to 57% (Rahayu et al., 2022). Other findings show that the application of Leva Nuang cultural values strengthens students' sense of social responsibility (Wuwur et al., 2023). In addition, culture-based learning using Minangkabau traditions has been empirically proven to enhance students' pride in regional culture and enrich their overall learning experience (Muin & Utami, 2024).

The utilization of local natural phenomena serves as a strategic alternative to improve the quality of contextual science learning. Local geographic potential and ecosystems can provide concrete contexts for explaining scientific concepts (Dasrol & Bachtiar, 2020). The Bono Wave phenomenon in the Kampar River, Riau, is one of the world's unique tidal bore occurrences, rich in both scientific and cultural values (Yani et al., 2022). Experimental research has demonstrated that learning based on local natural phenomena can enhance students' participation and scientific competence (Fauzi et al., 2022). The Bono Wave phenomenon embodies not only physical aspects such as waves and energy but also reflects the cultural values of the Kampar community. The local people perceive Bono as a symbol of harmony between humans and nature, a belief that has been passed down through generations (Dasrol & Bachtiar, 2020). Ethnographic studies reveal that the spiritual and social values embedded in this phenomenon can serve as educational materials to foster ecological awareness (Rehayati et al., 2022). Further research confirms that the integration of cultural elements in science learning can strengthen students' emotional connection to science (Rahayu et al., 2022).

This research method employed a One Group Pretest–Posttest design to measure the effectiveness of Bono Wave -based learning on students' scientific and cultural literacy. A similar design has been previously applied in physics learning research based on the Bundengan

cultural context and was proven to significantly improve students' learning outcomes (Rahayu et al., 2022). This experimental model is also considered capable of providing empirical evidence regarding the impact of cultural integration on science learning outcomes (Fauzi et al., 2022). Furthermore, project-based learning developed through a local cultural approach has been shown to enhance students' scientific literacy achievements (Ambarwati et al., 2025). The variables of this study consist of the integration of Bono Wave local culture as the independent variable, and students' scientific and cultural literacy as the dependent variables. Theoretical analysis suggests that local culture plays a crucial role in contextualizing scientific concepts and developing science understanding rooted in students' social experiences (Putra & Wahyuni, 2025). Science Learning that incorporates cultural values has also been proven to improve students' reflective thinking skills (Setiawan, 2024). Moreover, the fusion of culture and science in learning strengthens students' scientific identity as well as their ecological awareness (Muin & Utami, 2024).

Most previous studies on the integration of local wisdom in science education have focused on cultural, mythical, or social practices without linking them to specific natural phenomena with strong scientific potential. Research on Bundengan, Minangkabau, and Leva Nuang cultures has shown positive outcomes, yet there has been no quantitative empirical study directly examining the impact of the Bono Wave phenomenon on enhancing students' scientific and cultural literacy. This gap indicates the need for a new approach that combines the scientific and cultural potential of local natural phenomena within ethnoscience-based science learning. The novelty of this research lies in the development of a science learning model based on the integration of the Bono Wave phenomenon, which unites two key dimensions—scientific literacy and cultural literacy. Unlike previous studies that highlighted local culture symbolically, this study employs an actual natural phenomenon as both a scientific context and a representation of the cultural values of the Riau community. This integration makes science learning not only cognitive but also contextual and humanistic. The objectives of this study are to analyze the effectiveness of integrating the Bono Wave local culture in improving students' scientific literacy, to measure the enhancement of cultural literacy following the implementation of Bono Wave-based learning, and to identify the relationship between scientific and cultural literacy within the context of ethnoscience-based science education. Furthermore, this research is expected to produce a contextual learning model that aligns with Indonesia's local characteristics and supports the implementation of the Independent Curriculum.

2. Research Method

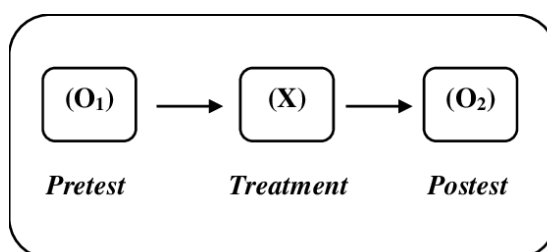
This study employed a quantitative approach using a pre-experimental design of the One Group Pretest–Posttest Design type (O_1-X-O_2). This design was used to measure the effectiveness of the Science learning model based on the integration of Bono Wave local culture in improving students' scientific literacy and cultural understanding. The population of this study consisted of all 21 fourth-grade students at SDN 105 Pekanbaru. The population was relatively small and homogeneous, a saturated sampling technique (total sampling) was used, whereby all members of the population were included as research participants. This technique was chosen to obtain comprehensive data and to avoid sampling bias (Hayuningtyas et al., 2018).

The research instruments comprised two main instruments and one supporting instrument. First, a scientific literacy test in the form of 10 multiple-choice questions was developed based on indicators of the ability to identify scientific phenomena, use scientific evidence, and interpret data. Second, a cultural literacy questionnaire was constructed using a four-point Likert scale (1–4) consisting of 16 statements covering three dimensions: cultural knowledge, attitudes toward local culture, and cultural participation. Prior to implementation, all instruments were piloted on a different sample possessing similar characteristics to the main study subjects to ensure validity and reliability.

The research procedure consisted of three main stages. The first stage was the pretest, aimed at identifying students' initial levels of scientific and cultural literacy before treatment.

The second stage was the treatment, which involved the implementation of Bono Wave - integrated science learning conducted in one 70-minute session. The learning activities included the exploration of the Bono wave phenomenon, a simple experiment on tidal movements, and a reflective discussion on the cultural and environmental values of the Kampar community. The third stage was the posttest, administered after the entire learning session to measure improvements in students' learning outcomes. The research flow is illustrated in Figure 1.

Figure 1. Research Flow



Data were analyzed quantitatively through several stages. First, a normality test was conducted using the Shapiro–Wilk test. Second, a Paired Sample t-Test was performed to determine the difference between the pretest and posttest results on students' scientific literacy and cultural understanding. Third, the N-Gain Score was calculated to assess the level of learning effectiveness (Maryadi, 2020). The validity and reliability of the instruments were ensured through statistical testing. Reliability testing was conducted using Cronbach's Alpha, and the instruments were considered reliable if the α value ≥ 0.70 (Rahman & Lestari, 2023). A high reliability coefficient indicates that the instrument consistently measures the same construct under different conditions. The scope of this study was limited to fourth-grade students at SDN 105 Pekanbaru; therefore, the findings cannot be generalized to other educational levels or cultural contexts. Moreover, since the research design did not include a control group, the influence of external factors—such as students' learning motivation or family support—could not be entirely isolated. The relatively short research period also posed a limitation in observing the long-term impact of culture-based learning on the development of students' scientific and cultural literacy. Hence, this research design is expected to provide empirical insights into the effectiveness of integrating the Bono Wave phenomenon into ethnoscience-based Science learning and to serve as a reference for developing contextual learning models that combine scientific and cultural values in Indonesian primary education.

3. Result and Discussion

After the completion of the entire *Bono Wave* - based science learning process integrating local culture, measurements of students' scientific and cultural literacy were conducted through pretest and posttest assessments. This measurement aimed to determine the extent to which the implementation of the learning model influenced the improvement of students' learning outcomes. The data obtained were analyzed both descriptively and inferentially to examine changes in mean scores, the significance of differences between pretest and posttest results, and the level of learning effectiveness based on the *N-Gain* calculation. The results of these analyses are presented sequentially, beginning with descriptive statistics, followed by difference testing,

and concluding with the interpretation of findings in relation to existing theories and previous research.

Results of the Scientific Literacy Test

The data on students' scientific literacy test results during the learning process integrating *Bono Wave* local wisdom into the topic of *Understanding Energy* are presented in Table 1.

Table 1. Pretest and Posttest Results of Scientific Literacy

Respondent	Pre test	Post Test
1	30	80
2	50	80
3	30	70
4	40	90
5	10	80
6	60	100
7	40	80
8	20	60
9	20	70
10	30	90
11	40	100
12	50	100
13	10	80
14	30	100
15	60	90
16	30	80
17	30	100
18	40	90
19	20	80
20	50	90
21	50	100
Total Score	740	1810
Mean	35,238	86,190
Highest Score	60	100
Lowest Score	10	60

Based on the pretest and posttest results presented in Table 1, a significant improvement in students' scientific literacy was observed after implementing *Bono Wave* - based learning. The mean pretest score of 35,23 indicated a low initial understanding of scientific concepts, while the posttest mean increased to 86,19, categorized as very good. This improvement demonstrates that contextual learning integrating the *Bono Wave* phenomenon effectively

enhanced students' conceptual comprehension. Moreover, the highest score rose from 60 to 100, and the lowest from 10 to 60, indicating that all students showed progress. Thus, the science learning model based on local wisdom proved effective in improving students' scientific literacy through contextual and meaningful learning experiences.

The Results of Cultural Understanding Questionnaire

The data from the cultural understanding questionnaire related to the *Bono Wave* phenomenon, collected during the learning process that integrated local wisdom into the topic *Understanding Energy*, are presented in Table 2.

Table 2. Results of the Cultural Understanding Questionnaire

Question	Mean Pretest	Mean Posttest	Initial Category	Final Category
1	2.8	3.8	Moderate	Very High
2	3.0	3.9	High	Very High
3	2.6	3.7	Moderate	Very High
4	3.2	4.0	High	Very High
5	2.9	3.8	Moderate	Very High
6	3.1	4.0	High	Very High
7	2.7	3.8	Moderate	Very High
8	2.5	3.6	Moderate	High
9	2.9	3.8	Moderate	Very High
10	2.4	3.5	Low	Tinggi
11	2.8	3.7	Moderate	Very High
12	2.6	3.6	Moderate	High
13	3.0	3.9	High	Very High
14	2.8	3.8	Moderate	Very High
15	2.7	3.7	Moderate	Very High
16	2.9	3.9	Moderate	Very High
Overall Mean	2.8	3.8	Moderate	Very High

The analysis of the cultural understanding questionnaire presented in Table 2 shows a significant improvement across all aspects of students' knowledge, attitudes, and participation toward the *Bono Wave* local culture. The mean score increased from 2.8 to 3.8, shifting from the *moderate* to the *very high* category. This indicates that integrating local culture into science learning not only enhances students' scientific understanding but also strengthens their cultural identity as members of the Riau community. The average scores of the 16 questionnaire items were further visualized through a bar chart, illustrating consistent improvement across all indicators, with the most notable increase observed in students' scientific understanding of the *Bono Wave* phenomenon and their pride in local culture.

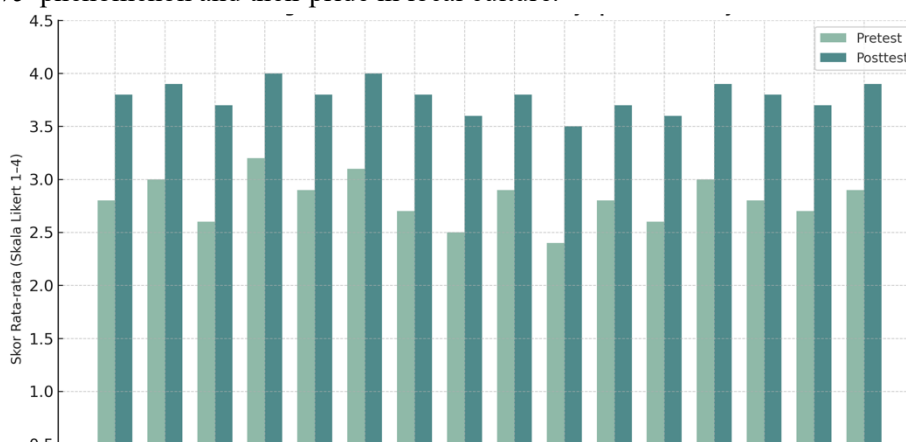


Figure 2. Comparison Diagram of Pretest and Posttest Mean Scores on the Cultural Understanding Questionnaire

Validity and Reliability Test

Before conducting the research, both the test items and questionnaires were piloted to ensure their validity and reliability in measuring the intended variables. The validity test was carried out to determine the extent to which each item in the scientific literacy instrument accurately measured the intended construct. The validity analysis employed the *Pearson Product Moment* correlation at a significance level of 5% ($\alpha = 0.05$) with a sample size of 21 respondents, resulting in an *r-table* value of 0.433 ($df = n - 2 = 19$).

Table 3. Results of the Validity Test for the Scientific Literacy Test

Item	r count	r table(0,433)	Sig. (2-tailed)	Criteria
1	0.58	0.433	0.007	Valid
2	0.32	0.433	0.072	Not Valid
3	0.64	0.433	0.003	Valid
4	0.25	0.433	0.134	Not Valid
5	0.61	0.433	0.005	Valid
6	0.4	0.433	0.062	Not Valid
7	0.47	0.433	0.029	Valid
8	0.59	0.433	0.006	Valid
9	0.68	0.433	0.001	Valid
10	0.56	0.433	0.009	Valid
11	0.29	0.433	0.098	Not Valid
12	0.63	0.433	0.004	Valid
13	0.71	0.433	0.0	Valid
14	0.44	0.433	0.043	Valid
15	0.35	0.433	0.083	Not Valid

Based on the table above, out of the 15 items tested, 10 were found to be valid (items 1, 3, 5, 7, 8, 9, 10, 12, 13, and 14), while 5 items were not valid. The invalid items were excluded from the reliability test and subsequent analyses. The results of the reliability test for the scientific literacy questionnaire are presented in Table 4

Table 4. Results of the Reliability Test for the Scientific Literacy Questionnaire

Item	Mean	Si ²	St ²	Note
1	0.5238	0.2619	11.0476	Valid
3	0.7143	0.2143	11.0476	Valid
5	0.5714	0.2571	11.0476	Valid
7	0.5714	0.2571	11.0476	Valid
8	0.5238	0.2619	11.0476	Valid
9	0.4286	0.2571	11.0476	Valid
10	0.3333	0.2333	11.0476	Valid
12	0.3333	0.2333	11.0476	Valid
13	0.2381	0.1905	11.0476	Valid
14	0.3810	0.2476	11.0476	Valid

Based on the data obtained in Table 5, the calculated values were then substituted into the formula, resulting in the following outcome:

$$\alpha = (10 / 9) \times [1 - (2.4143 / 11.0476)]$$

$$\alpha = 1.111 \times [1 - 0.2185] = 0.868$$

Thus, the reliability coefficient (*Cronbach's Alpha*) for the scientific literacy test was 0.868. Based on general criteria, an α value of 0.868 falls within the *high* category, indicating that the instrument possesses adequate internal consistency. Similarly, a validity test was also conducted for the cultural understanding questionnaire, following the same procedure as that used for the scientific literacy questionnaire. The results of the validity test for the cultural understanding questionnaire are presented in Table 5 below.

Table 5. Results of the Validity Test for the Cultural Understanding Questionnaire

Item	r count	r table (0,433)	Sig. (2-tailed)	Criteria
1	0.62	0.433	0.003	Valid
2	0.31	0.433	0.17	Not Valid
3	0.66	0.433	0.002	Valid
4	0.45	0.433	0.039	Valid
5	0.28	0.433	0.218	Not Valid
6	0.52	0.433	0.017	Valid
7	0.47	0.433	0.029	Valid
8	0.59	0.433	0.005	Valid
9	0.71	0.433	0.0	Valid
10	0.56	0.433	0.009	Valid
11	0.35	0.433	0.118	Not Valid
12	0.63	0.433	0.003	Valid
13	0.68	0.433	0.001	Valid
14	0.44	0.433	0.046	Valid
15	0.53	0.433	0.015	Valid
16	0.49	0.433	0.022	Valid
17	0.38	0.433	0.089	Not Valid
18	0.72	0.433	0.0	Valid
19	0.57	0.433	0.008	Valid
20	0.6	0.433	0.004	Valid

Based on the table above, out of 20 statements in the cultural understanding questionnaire, 16 items were found to be valid (items 1, 3, 4, 6, 7, 8, 9, 10, 12, 13, 14, 15, 16, 18, 19, and 20), while 4 items were not valid (items 2, 5, 11, and 17). The invalid items were excluded from further analyses, such as the reliability test and main data analysis. The results of the reliability test for the cultural understanding questionnaire are presented in Table 6.

Table 6. Results of the Reliability Test for the Cultural Understanding Questionnaire

Item	Si ²	St ²	Criteria
1	1.24	5.38	Valid
3	1.12	5.38	Valid
4	0.98	5.38	Valid
6	1.08	5.38	Valid
7	0.95	5.38	Valid
8	1.21	5.38	Valid
9	1.15	5.38	Valid
10	0.89	5.38	Valid
12	1.05	5.38	Valid
13	1.1	5.38	Valid
14	0.92	5.38	Valid
15	1.0	5.38	Valid
16	0.94	5.38	Valid
18	1.2	5.38	Valid
19	1.07	5.38	Valid
20	0.91	5.38	Valid

Using the *Cronbach's Alpha* formula

$$\alpha = (16 / 15) \times [1 - (15.81 / 5.38)]$$

$$\alpha = 1.066 \times [1 - 0.472] = 1.066 \times 0.528 = 0.872$$

The reliability coefficient for the cultural understanding questionnaire was found to be 0.872. According to the reliability interpretation criteria proposed by George and Mallery (2003), this value falls within the *high* category. This indicates that the cultural understanding questionnaire has good reliability and can be consistently used to measure respondents' cultural understanding.

Normality Test

Before hypothesis testing, a normality test was conducted to determine whether the research data were normally distributed. This test was necessary to select the appropriate statistical analysis method—either parametric or non-parametric. In this study, the normality test was applied to the total score data of the scientific literacy and cultural understanding

variables using the *Shapiro–Wilk* test, as the number of respondents was fewer than 50 (Ghasemi & Zahediasl, 2012).

Table 7. Results of the Normality Test for the Scientific Literacy and Cultural Understanding Questionnaires
Tests of Normality

	Kolmogorov-Smirnov ^a			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Cultural Understanding	.168	21	.126	.943	21	.254
Science Literacy	.197	21	.033	.911	21	.057

a. Lilliefors Significance Correction

Based on the results of the normality test presented in Table 7, the normality test for the difference data (posttest–pretest) was conducted using the *Shapiro–Wilk* test, as the number of respondents was fewer than 50. The results showed that the significance (Sig.) value for the cultural understanding variable was 0.254, and for the scientific literacy variable was 0.057. Both significance values were greater than 0.05, indicating that the data were normally distributed. Therefore, the data met the assumption of normality, allowing the hypothesis testing to proceed using the *Paired Sample t-Test*.

Hypothesis Test

Based on the normality test results showing that the data were normally distributed, the next analytical stage was hypothesis testing. This test aimed to determine whether there was a significant difference between students' learning outcomes before and after the treatment. The hypothesis testing employed the *Paired Sample t-Test*, as the pretest and posttest data were obtained from the same subjects, allowing for the measurement of changes resulting from the intervention. This test was conducted to assess the effectiveness of the learning model in improving students' scientific literacy and cultural understanding. Additionally, an *N-Gain* analysis was performed to further evaluate the level of improvement in learning outcomes. Through both analyses, empirical evidence was obtained regarding the impact of the implemented learning model on enhancing students' scientific and cultural literacy significantly.

Table 8. Results of the Paired Sample t-Test for Scientific Literacy

Mean	Paired Differences			t	df	Sig. (2-tailed)
	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
			Lower			
			Upper			
	n	n				

Pai	Pretest_Science_Literacy	-	12.611	2.752	-	-	-	2	.000
r 1	-	50.95			56.69	45.21	18.51	0	
	Posttest_Science_Literacy	2			3	2	4		

The results of the analysis using the *Paired Sample t-Test* revealed a significant difference between the pretest and posttest scores for the scientific literacy variable ($t(20) = -18.514$, $p < 0.05$). The mean difference of -50.952 indicates that the posttest scores were significantly higher than the pretest scores. Therefore, the hypothesis stating that there is a significant difference between students' learning outcomes before and after the implementation of the learning model in terms of scientific literacy is accepted. This finding demonstrates that the application of the learning model had a positive and significant effect on improving students' scientific literacy.

Table 9. Results of the Paired Sample t-Test for Cultural Understanding

		Paired Differences						
					95% Confidence Interval of the Difference			Sig. (2- tailed)
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df
Pair	Pretest_Cultur	-	4.092	.893	-	-	-	20
1	Understanding Posttes Culture Understanding	15.048			16.910	13.185	16.850	.000

Based on the results of the *Paired Sample t-Test*, the mean difference was -15.048 , with $t = -16.850$, $df = 20$, and a significance value (Sig. 2-tailed) of $0.000 (< 0.05)$. These results indicate a significant difference between the pretest and posttest scores for the cultural understanding variable. Therefore, it can be concluded that students' cultural understanding increased significantly after the implementation of the learning model used in this study.

Following the hypothesis test, which confirmed a significant difference between learning outcomes before and after the treatment, an *N-Gain* analysis was conducted to evaluate the level of effectiveness in improving students' learning outcomes. The *N-Gain* test was employed to measure how effectively the applied learning model improved performance based on the difference between pretest and posttest scores. The analysis was calculated using the formula developed by Hake, (1999), which compares the actual score improvement to the maximum possible gain. The *N-Gain* results provide quantitative information regarding the effectiveness of learning improvement, classified into three categories: high, moderate, and low.

**Table 10. Results of N-Gain Analysis for Scientific Literacy
and Cultural Understanding**

Variabel	Mean			Kategori
	Post test	Pre Test	N Gain	
Science Literacy	35,238	86,190	0,798	Tinggi
Cultural Understanding	37,714	59,66	0,332	Sedang
Rata Rata Total			0,565	Sedang

Based on the results of the *N-Gain* analysis presented in Table 10, the average improvement score for the scientific literacy variable was 0.798, categorized as *high*, while the cultural understanding variable obtained a score of 0.332, categorized as *moderate*. Overall, the total mean *N-Gain* score of 0.565 indicates a *moderate* category. These findings suggest that the applied learning model was fairly effective in improving students' learning outcomes, particularly in scientific literacy, which demonstrated high effectiveness. Meanwhile, the moderate improvement in cultural understanding indicates the need to strengthen contextual learning strategies to further enhance students' cultural awareness. This finding aligns with Wahab et al., (2021) who reported that higher *N-Gain* values are associated with more optimal learning effectiveness. Therefore, the implementation of this learning model can be considered to have a positive effect on improving student learning outcomes, although the level of effectiveness varies between variables.

Although scientific literacy showed a high increase, the moderate level of cultural understanding effectiveness suggests that the internalization of cultural values through the *Bono Wave* context has not yet been fully optimized. The *Bono* phenomenon is not only a scientific object but also a symbol of Riau's cultural identity that deserves to be revitalized within the educational context. According to Eliyanti et al., (2024) local culture-based learning strengthens students' cultural identity and awareness, while Kuswantara, (2023) found that the implementation of culture-based education fosters character development and appreciation of regional heritage. Similarly, Saputra et al., (2025) emphasized that learning experiences linking local culture with science can shape students' scientific and social identities. Thus, the integration of *Bono Wave* not only strengthens scientific literacy but also serves as a medium for building contextual cultural awareness.

The effectiveness of *Science* learning using the *Bono wave* context is evident not only from the score differences but also from students' engagement in scientific reasoning processes. Through the exploration of the tidal wave phenomenon of *Bono*, students directly learn about the concepts of waves, energy, and natural forces, thereby improving their conceptual understanding and scientific literacy. The inquiry-based approach utilizing local phenomena has been shown to enhance students' critical and scientific thinking skills Cahyani et al., (2025) Meanwhile, multicultural learning that incorporates regional cultures such as *Bono Wave* fosters social awareness and cultural appreciation (R. Setiawan, 2023). Anggraini et al., (2023) further asserted that integrating local contexts into science learning helps students understand the interconnection between natural phenomena and cultural values. Therefore, *Bono Wave* - based learning effectively combines scientific inquiry with culturally grounded character education.

4. Conclusion

This study concludes that the integration of *Bono Wave* local wisdom into *Science* learning proved effective in improving students' learning outcomes, particularly in the aspects of scientific and cultural literacy. Based on the results of the *Paired Sample t-Test*, there was a significant difference between the pretest and posttest scores for both variables. The average *N-Gain* value of 0.565 indicated a moderate level of effectiveness, with the highest increase observed in scientific literacy (0.798, high category) and a moderate increase in cultural literacy (0.332). These findings demonstrate that the *Bono Wave* local context serves as a meaningful and relevant medium for connecting scientific concepts with the cultural values of the Kampar community. Importantly, the results highlight that integrating natural phenomena with local culture not only enhances scientific understanding but also strengthens students' ecological awareness and cultural identity. This approach provides a substantial contribution to the development of ethnoscience-based *Science* learning models in elementary schools, aligning with the goals of the *Merdeka Curriculum* to cultivate students with strong character and critical thinking skills. Scientifically, this research reaffirms that culture-based contextual learning—such as the *Bono Wave* model—is a promising pedagogical reference for further development. The model offers a contextual learning strategy that goes beyond cognitive outcomes to foster students' social, cultural, and ecological awareness. Hence, this study provides valuable empirical evidence supporting the advancement of local wisdom-based educational innovation in Indonesia.

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