



## The Quality of Science Literacy Instruments on Harmonic Vibration Material: Integration of Baayun Maulid Local Wisdom with Pancasila Student Profiles

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### Abstract

This study aims to describe the quality of a scientific literacy instrument on harmonic oscillation topics that integrates Baayun Maulid local wisdom and the Pancasila Student Profile. The research employed a Research and Development (R&D) design based on the Sugiyono model. In the development stage, design validity was obtained with very good results. A pilot study involving 20 items was conducted, and 12 items met the criteria of validity, reliability, difficulty level, and discrimination power, while the rest were revised or discarded. These 12 items were then used in the large-scale trial (field testing). The trial, conducted in the eighth stage of development, involved 97 students from three senior high schools in Banjarmasin. The analysis showed that 10 of the 12 items fulfilled the required psychometric criteria, while 2 items did not and were eliminated. The findings indicate that the instrument meets the standards of a quality evaluation tool. The implication of this study is the availability of a relevant instrument to assess scientific literacy while embedding local cultural values and character education aligned with the Pancasila Student Profile. This instrument provides an alternative for contextual science assessment and contributes to the development of evaluation practices consistent with national minimum competency assessment standards.

**Keywords:** Scientific Literacy; Baayun Maulid; harmonic oscillation; local wisdom; Pancasila Student Profiles

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## INTRODUCTION

The quality of education in Indonesia remains suboptimal, partly due to the low level of students' scientific literacy. This issue arises because learning in Indonesia has not been fully oriented toward the demands of the 21st century, which emphasize scientific literacy (Dewantara et al., 2019; Dewi et al., 2021; Rusmansyah et al., 2023; Sjöström, 2025; Wati et al., 2023). In addition, learning evaluations are often ineffective, as they tend to measure only knowledge without involving critical thinking skills or the ability to apply concepts in daily life (Handayani & Khairuna, 2022; Hidayat et al., 2021; Sangadah et al., 2025; Wati et al., 2023). In fact, evaluation is an essential component for monitoring the process and improving students' learning outcomes continuously.

The ineffectiveness of learning evaluations may be caused by various factors, one of which is the use of test instruments that do not meet evaluation standards (Hanfstingl et al., 2024; Rusilowati et al., 2016; Stylos et al., 2023). A good evaluation instrument should be

valid, reliable, and practical, as stated by Burden and Byrd. Evaluation can only be considered successful if it performs its main function as an accurate and fair measurement tool. The ineffectiveness of evaluation instruments has become a serious problem in the education system, contributing to the low quality of education in Indonesia (Asmayawati et al., 2024; Monica et al., 2024).

Data from the Programme for International Student Assessment (PISA) highlight the low achievement of Indonesian students in scientific literacy. From 2000 to 2018, Indonesia's scientific literacy score remained at 396, ranking 71st out of 79 participating countries. This condition indicates that students are not yet able to fully understand scientific concepts, let alone apply them in everyday life.

Indonesian students tend to memorize theories but are weak in applying concepts. As a result, when confronted with scientific literacy-based tests or minimum competency assessments, students are often unprepared. Therefore, it is necessary to develop learning strategies and evaluation instruments that integrate scientific literacy and are oriented toward minimum competency assessments. Through this approach, students are expected to develop scientific skills while achieving learning objectives more comprehensively.

In the early stage of this research, design validity was carried out with very good results. A pilot study involving 21 items of scientific literacy questions based on Baayun Maulid local wisdom and the Pancasila Student Profile was also conducted. The results showed that 12 items fulfilled the criteria of validity, reliability, difficulty level, and discrimination power, while the remaining items were revised or eliminated. These 12 selected items were then prepared for the large-scale trial.



**Figure 1.** Rows of swings used in the *Baayun Maulid* tradition in South Kalimantan.

*Source: Author's documentation*

Scientific literacy can be defined as the ability to understand scientific concepts and apply them in real-life contexts (Ahmad et al., 2025; Ellianawati et al., 2025; Fortus et al., 2022; Hartini et al., 2019; Li & Guo, 2021; Zuhrotul Wardi et al., 2024). One potential approach is the integration of scientific literacy with local wisdom (Fitri et al., 2025; Fitriah et al., 2025; Hartini et al., 2024; Lubis et al., 2022; Saphira, 2022; Verawati & Wahyudi, 2024). The Baayun Maulid tradition from South Kalimantan can serve as a concrete example. The swinging procession in this tradition can be explained through physics concepts such as simple harmonic motion, gravitational force, and mechanical energy. Thus, this tradition provides a contextual opportunity to develop students' scientific literacy. The following table illustrates the integration of the Baayun Maulid tradition into physics learning in accordance with scientific literacy indicators:

**Table 1.** Integration of the Baayun Maulid Tradition into Physics Learning Based on Scientific Literacy Indicators

<b>Scientific Literacy Indicator</b>	<b>Context in Baayun Maulid Tradition</b>	<b>Student Activities</b>
Explaining scientific phenomena	The swinging motion in the Baayun Maulid procession can be understood through the concepts of simple harmonic motion, gravitational force, and mechanical energy.	Students explain why the swing can move back and forth, the factors influencing the swing's period, and the relationship between string length and frequency.
Evaluating & designing scientific investigations	The tradition provides opportunities to test physics principles through direct observation of the swing.	Students design a simple experiment: measuring the string length and swing period, as well as evaluating the safety factors of the rope and swing seat.
Interpreting data & scientific evidence	Data from measurements of string length, period, and frequency can be used to understand physical laws.	Students analyze the measurement results, compare them with theory, and draw conclusions about the alignment of cultural practices with scientific principles.

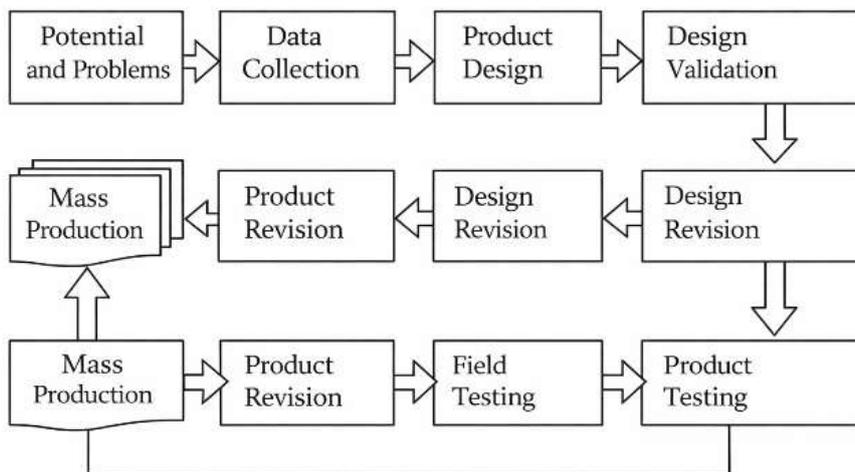
This integration allows students not only to understand the theory but also to experience it directly through local culture. For example, they can measure the length of the swing rope, calculate the frequency, or assess the strength of the swing seat. These activities train critical and analytical thinking skills while fostering awareness that science exists in everyday life, including in cultural practices.

A number of studies support culturally contextual approaches in science learning. The integrating local cultural values can increase the relevance of learning materials to students' lives. The students find it easier to understand scientific concepts when the material is linked to local cultural practices, such as Baayun Maulid (Wati et al., 2019). The culture-based projects can significantly improve students' scientific literacy (Saripudin et al., 2022). A culture-based STEAM approach can enhance creativity as well as 21st-century skills.

Based on this description, there is a clear gap between the demands of scientific literacy and the actual conditions of education in Indonesia. On the one hand, scientific literacy and the Minimum Competency Assessment are urgent needs to prepare students to face global challenges. On the other hand, local cultural potential such as Baayun Maulid can serve as a relevant contextual learning medium. Therefore, this research was conducted to develop a scientific literacy instrument based on the Minimum Competency Assessment by integrating the Baayun Maulid tradition as a physics learning context. Therefore, this research was conducted to conduct a large-scale trial of a scientific literacy instrument developed through previous design validation and pilot study, by integrating the Baayun Maulid tradition as a physics learning context.

## METHOD

Research and Development (R&D) was the model employed in this study. R&D represents a systematic and structured process aimed at producing a product that is valid, practical, and effective. The development model used was Sugiyono's model, which consists of ten stages, as shown in Figure 2.



**Figure 2.** Steps of the R&D Method in Sugiyono’s Development Model

The development model begins with identifying the potential and problems, followed by data collection to provide a foundation for product design. Once the initial product design is created, it undergoes validation by experts to ensure its feasibility. Based on the validation results, revisions are made to improve the design before proceeding to product trials. After the trial, further revisions are carried out to refine the product. The revised product is then tested through usage trials in a real setting to evaluate its practicality and effectiveness. Additional revisions may be conducted based on the trial feedback. Finally, when the product has met all the required standards and criteria, it is ready for large-scale production and implementation.

The developed instrument encompasses indicators of scientific literacy, local wisdom, and the Profil Pelajar Pancasila. Each item is designed as a multiple-choice question with reasoning, requiring students not only to select an answer but also to provide justification and problem-solving steps. In the large-scale trial phase, the instrument will be re-analyzed in terms of validity, reliability, difficulty level, and discrimination power. This process is expected to produce a final instrument of high quality that can be more broadly applied to measure scientific literacy on the topic of harmonic oscillations.

**Validity**

The validity test was conducted to determine the feasibility and accuracy of the obtained data, as well as to identify the presence of any errors. The data were considered valid if they met at least two out of three validity criteria.

**Tabel 1.** Validity Criteria

Validity Criteria	Range
Outfit mean square (MNSQ)	$0.5 < MNSQ < 1.5$
Outfit Z-standar	$-2.0 < ZSTD < +2.0$
Point Measure Correlation	$0.4 < Pt. measure < 0.85$

**Reliability**

Reliability is often defined as the degree of consistency of an instrument. An instrument with high reliability will produce relatively similar measurement results even when used repeatedly under comparable conditions. Thus, reliability reflects the extent to which an instrument can be trusted to generate stable and consistent data.

In this study, reliability testing was carried out using the Rasch model. Rasch analysis allows for measuring reliability from both the participant side (person reliability) and the item side (item reliability). Person reliability indicates the consistency of participants’ responses to the items, while item reliability shows the consistency of item quality in measuring scientific literacy skills.

**Table 2.** Criteria for Person and Item Reliability

Reliability Range	Category
< 0.67	Weak
0.67 – 0.80	Fair
0.81 – 0.90	Good
0.91 – 0.94	Very Good
> 0.94	Excellent

### Difficulty Level

In the Rasch model, the difficulty level of test items is categorized based on the logit measure and the standard deviation (SD) of item logits, which are divided into four categories as follows:

**Table 3.** Categories of Item Difficulty Level

Range Measure (Logit)	Interpretation of Item Difficulty
Measure logit < -SD Logit	Easy
- SD Logit $\leq$ Measure Logit $\leq$ 0.00	Moderate
0 $\leq$ Measure logit $\leq$ SD Logit	Difficult
Measure Logit > SD Logit	Very Difficult

### Discriminating Power

The measure of discriminating power (symbolized as  $D$ ) is the difference between the proportion of the high group that answers correctly and the proportion of the low group that answers correctly on the analyzed item. If the item has a high  $D$  value, it indicates that the item possesses very good discriminating characteristics. Discriminating power can be seen from the Person Measure Correlation found in the Rasch model output, where the interpretation of the discriminating power index is usually presented in Table 4.

**Table 4.** Interpretation of the Discriminating Power Index

Discriminating Power Index	Category
$0.40 \leq D < 1.00$	Very Good
$0.30 \leq D < 0.39$	Good
$0.20 \leq D < 0.29$	Medium
$0.00 \leq D < 0.19$	Poor
Negative	Bad

## RESULT AND DISCUSSION

### Validity Design

Based on the results of the design validation carried out by five validators, the developed science literacy instrument integrating Baayun Maulid local wisdom and the Pancasila Student Profile was declared highly valid in terms of construction, language, and material, making it feasible for further trials. However, the validators provided several recommendations for improvement, including refining sentence structures to be clearer and more realistic, avoiding ambiguous wording, enhancing the clarity of images used in the questions, adding a detailed scoring system for each item, and adjusting the cognitive level of the questions to align with the intended science literacy indicators (Maulida et al., 2025).

### Pilot Study

Based on the results of the pilot study, twelve items met the criteria for validity, reliability, difficulty level, and discrimination power, making them suitable for use in the large-scale implementation stage. Three items were found to be invalid, and six items demonstrated poor discrimination, requiring revision or elimination in the subsequent phase. These findings

indicate that the scientific literacy instrument, which integrates the local wisdom of Baayun Maulid and the Profil Pelajar Pancasila, holds potential as a relevant and contextual assessment tool aligned with national cultural values and character. As a follow-up, the research will proceed to the large-scale trial involving a greater and more diverse number of respondents to comprehensively confirm the quality of the instrument through further analysis of validity, reliability, difficulty level, and discrimination power. Thus, this instrument is expected to be widely applicable in measuring scientific literacy on harmonic oscillation topics while simultaneously supporting the achievement of the Profil Pelajar Pancasila.

### Implementation trial

The implementation trial was conducted in three schools representing high, medium, and low categories. A total of 97 students participated, consisting of 33 students from SMA Negeri 1 Banjarmasin, 38 students from SMA Negeri 4 Banjarmasin, and 26 students from SMA Negeri 12 Banjarmasin. The instrument consisted of 12 test items. The data obtained were analyzed using the Rasch model to determine the validity, reliability, difficulty level, and discrimination power of the items in the scientific literacy instrument on harmonic oscillations, which integrates the local wisdom of *Baayun Maulid* and the *Profil Pelajar Pancasila*.

### Validity

Validity in the Rasch program can be observed in the output Table 13 (Appendix 8). The results were then compared with the minimum criteria of fulfilling at least two indicators: Outfit MNSQ ( $0.5 < \text{MNSQ} < 1.5$ ), ZSTD ( $-2.0 < \text{ZSTD} < +2.0$ ), and Point Measure Correlation ( $0.4 < \text{Pt. Measure} < 0.85$ ). The results of the analysis are presented in Table 5.

**Table 5.** Item Validity

Item	Outfit MNSQ	ZSTD	Point Measure Correlation	Remarks
1	0.49	-0.89	0.50	Valid
2	2.29	2.43	0.41	Invalid
3	4.09	3.43	0.05	Invalid
4	0.73	-0.95	0.70	Valid
5	0.51	-1.87	0.74	Valid
6	1.16	0.52	0.59	Valid
10	0.63	-1.68	0.77	Valid
11	0.63	-1.60	0.75	Valid
13	1.03	0.21	0.64	Valid
15	0.84	-0.47	0.67	Valid
17	0.83	-0.64	0.69	Valid
20	0.92	-0.30	0.70	Valid

Based on Table 5, two items did not meet at least two of the validity criteria (MNSQ, ZSTD, and Point Measure Correlation), and thus were considered invalid.

The validity of test items in the Rasch model can be determined using three main indicators: the Outfit Mean Square (MNSQ), the Z-Standard (ZSTD), and the Point Measure Correlation (Pt Measure Corr). An item is considered valid if it meets at least two of the following criteria: an Outfit MNSQ value between 0.5 and 1.5, a ZSTD value between  $-2.0$  and  $+2.0$ , and a Point Measure Correlation value between 0.4 and 0.85. Based on the analysis results in Table 4.6, two items did not meet the validity criteria and were therefore removed. Meanwhile, the ten items that met the criteria indicate that the items are sound in terms of measurement and quality.

The invalidity of the two items was due to many students experiencing difficulties in answering them, stemming from a lack of understanding of the fundamental concepts of

harmonic oscillations. Common errors included students' inattention to positive and negative signs in calculations, as well as difficulties in interpreting the data or information presented in the items. This finding highlights the need for greater emphasis on conceptual understanding and analytical skills in science learning to improve students' science literacy abilities.

### Reliability

In the Rasch program (Winsteps), reliability can be determined from the output in Table 6, which provides person reliability and item reliability values.

**Table 6.** Item Reliability Analysis

Reliability	Value	Category
Person reliability	0.83	Good
Item reliability	0.97	Excellent

The analysis shows that person reliability was 0.83, categorized as good, which means students' responses to the instrument were consistent. Meanwhile, item reliability was 0.97, categorized as excellent, indicating that the items in the instrument demonstrated a very high degree of consistency.

Reliability refers to the extent to which the results of a measurement can be trusted. The reliability of students' responses to the test items is indicated by *person reliability*, while the reliability of the test items themselves is indicated by *item reliability*. Based on the analysis results presented in the table, the person reliability value was 0.83, which falls into the "good" category, and the item reliability value was 0.97, which falls into the "excellent" category. This indicates that students' responses were consistent when answering the science literacy test items, and that the quality of the items demonstrated strong consistency in terms of reliability. Reliability is associated with the accuracy of an instrument in measuring what it is intended to measure, the precision of the measurement results, and the degree of accuracy if the measurement were to be repeated.

### Difficulty Level

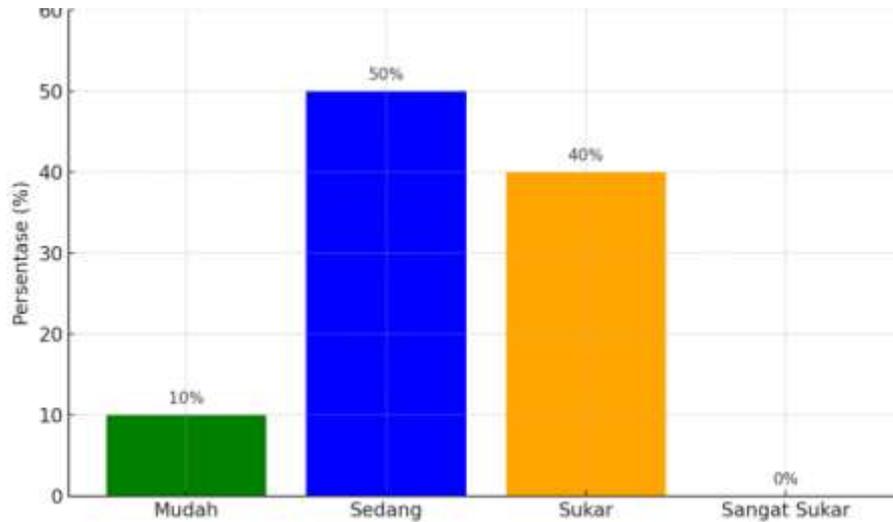
In Rasch modeling, item difficulty is categorized based on the logit measure and the Standard Deviation (SD) of item logits.

**Table 7.** Item Difficulty Analysis (SD Logit = 1.33)

Logit Measure Value	Item Difficulty Interpretation	Items
Measure logit < -1.33	Easy	1
$-1.33 \leq \text{Measure Logit} \leq 0.00$	Moderate	4, 5, 15, 13, 6, 2
$0 \leq \text{Measure logit} \leq 1.33$	Difficult	20, 10, 17, 11
Measure Logit > 1.33	Very Difficult	3

The results in Table 7 show that there was one easy item, six moderate items, four difficult items, and one very difficult item. The difficulty level of test items in the Rasch model is expressed in logits and categorized based on the standard deviation (SD) value of the logit. The difficulty levels of the items can be seen in Appendix 10. Based on the calculation results, the logit SD was found to be 1.33. Accordingly, it was obtained that one item was classified as easy, meaning that most students were able to answer it correctly; six items were of medium difficulty; four items were difficult; and one item was very difficult, indicating that only a very small number of students were able to answer it correctly. The variation in item difficulty ranged from easy to very difficult, but the distribution was not yet fully balanced. Therefore, an adjustment in item difficulty is needed to provide a more even measurement of students' abilities.

In general, a test item is considered good if it is neither too difficult nor too easy. A test item that cannot be answered correctly by any of the participants (because it is too difficult) is categorized as a poor-quality item. Conversely, a test item that can be answered correctly by all participants (because it is too easy) is also considered a poor-quality item.



**Figure 3.** Bar chart of the difficulty level of the final exam items

### Discrimination Power

The discrimination index (D) is the difference between the proportion of high-ability students who answered correctly and the proportion of low-ability students who answered correctly on a given item. A higher D value indicates stronger discrimination.

**Table 8.** Item Discrimination Power

Discrimination Index	Category	Items
$0.40 \leq D < 1.00$	Very Good	2, 6, 13, 15, 17, 4, 20, 10, 11, 1, 5
$0.30 \leq D < 0.39$	Good	-
$0.20 \leq D < 0.29$	Fair	-
$0.00 \leq D < 0.19$	Poor	3
Discrimination Index	Category	Items

The item discrimination indicates the extent to which a question can differentiate between students with high and low abilities. In the Rasch model, discrimination is observed through the Point Measure Correlation value. Items with a correlation value above 0.40 are categorized as very good, values between 0.30–0.39 as good, 0.20–0.29 as moderate, 0.00–0.19 as poor, and negative values as unacceptable. The analysis results show that eleven items fall into the very good category, meaning these items are highly effective in distinguishing students with high science literacy from those with low science literacy. One item falls into the poor category, indicating that it is less effective in differentiating between students with high and low science literacy. The classification of item discrimination is determined based on the item discrimination index (D). In other words, if an item has good discrimination, it can effectively distinguish between students with high and low ability.

### Items Based on Learning Objectives with Good Quality

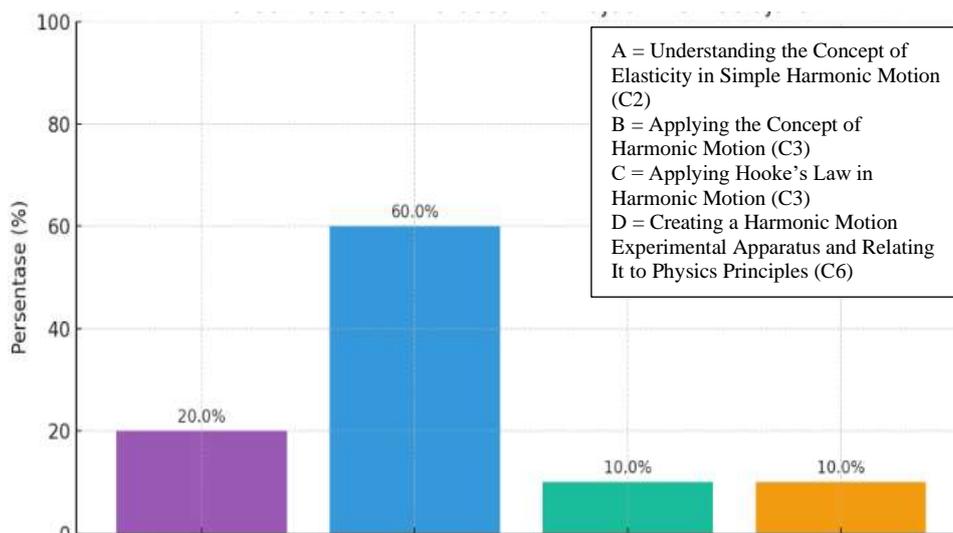
Based on the analysis of the 10 developed items, it is evident that the questions have been designed in accordance with the learning objectives, covering various cognitive levels in Bloom's Taxonomy. Two items (20%) were designed to assess students' understanding of the concept of elasticity in simple harmonic motion (C2). These questions focus on mastering basic

concepts, such as restoring force, spring constant, and the relationship between mass and oscillation period. This serves as a conceptual foundation for students before moving on to the application stage.

**Table 9.** Item Analysis Based on Learning Objectives

Learning Objective	Item	Validity	Difficulty Level	Discrimination Power
Understanding Elasticity Concepts in Simple Harmonic Oscillation (C2)	10	Valid	Difficult	Very Good
	11	Valid	Difficult	Very Good
Applying Harmonic Oscillation Concepts (C3)	1	Valid	Easy	Very Good
	4	Valid	Moderate	Very Good
	5	Valid	Moderate	Very Good
	6	Valid	Moderate	Very Good
	13	Valid	Moderate	Very Good
Applying Hooke’s Law in Harmonic Oscillation (C3)	15	Valid	Moderate	Very Good
	17	Valid	Difficult	Very Good
Designing Harmonic Oscillation Experiments and Connecting Physical Principles (C6)	20	Valid	Difficult	Very Good

Next, six items (60%) emphasize the ability to apply harmonic motion concepts (C3). The distribution of items in this domain indicates that the instruction aims to train students to apply formulas and principles of harmonic motion in real-world contexts and calculation problems, thereby strengthening problem-solving skills in physics. Additionally, one item (10%) specifically assesses students’ ability to apply Hooke’s Law in the context of harmonic motion (C3). This question evaluates the extent to which students understand the relationship between force, spring deformation, and the spring constant in oscillatory systems.



**Figure 4.** Bar chart of items based on learning objectives

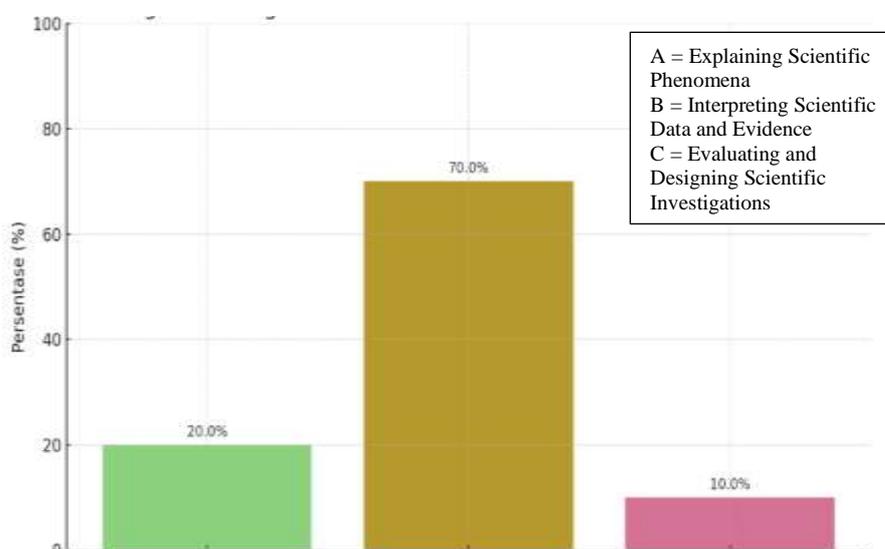
Finally, one item (10%) falls within the C6 domain, which involves creating a simple harmonic motion experimental apparatus and connecting it to relevant physics principles. This question encourages students to think creatively and reflectively, demonstrating their understanding through experiment design or simple modeling.

### Items Based on Scientific Literacy Indicators

Each item in the science literacy instrument refers to the science literacy indicators, namely explaining scientific phenomena, interpreting scientific data and evidence, and evaluating and designing scientific investigations. The alignment between the items and the science literacy indicators is crucial to ensure that the questions can comprehensively assess students' science literacy skills. Such items encourage students to think critically in processing information. Therefore, a strong connection between the questions and the science literacy indicators is one effective way to enhance students' science literacy.

**Table 10.** Item Analysis Based on Scientific Literacy Indicators

Scientific Literacy Indicator	Item Numbers
Explaining scientific phenomena	10, 11
Interpreting data and scientific evidence	1, 4, 5, 6, 13, 15, 17
Evaluating and designing scientific investigations	20



**Figure 4.** Bar Chart Based on Science Literacy Indicators

### Items Based on Profil Pelajar Pancasila

The developed instrument also integrates the values of the Pancasila Student Profile. This indicates that the instrument's development not only focuses on cognitive aspects but also aims to shape students' character in accordance with the objectives of the Merdeka Curriculum, while encouraging students to practice Pancasila values in daily life. An analysis of the items based on the Pancasila Student Profile shows that most questions have been directed toward strengthening students' character in line with the values promoted by the curriculum. Nevertheless, some items still need refinement to more comprehensively reflect Pancasila values in the educational process. Therefore, the development of items should cultivate well-rounded students in terms of knowledge, skills, and attitudes.

**Table 11.** Item Analysis Based on Profil Pelajar Pancasila Indicators

Pancasila Student Profile Indicator	Item Numbers
Faith in God Almighty and noble character	6
Global diversity	1
Collaboration	4, 5, 13, 15
Creativity	17, 20
Independence	10, 11

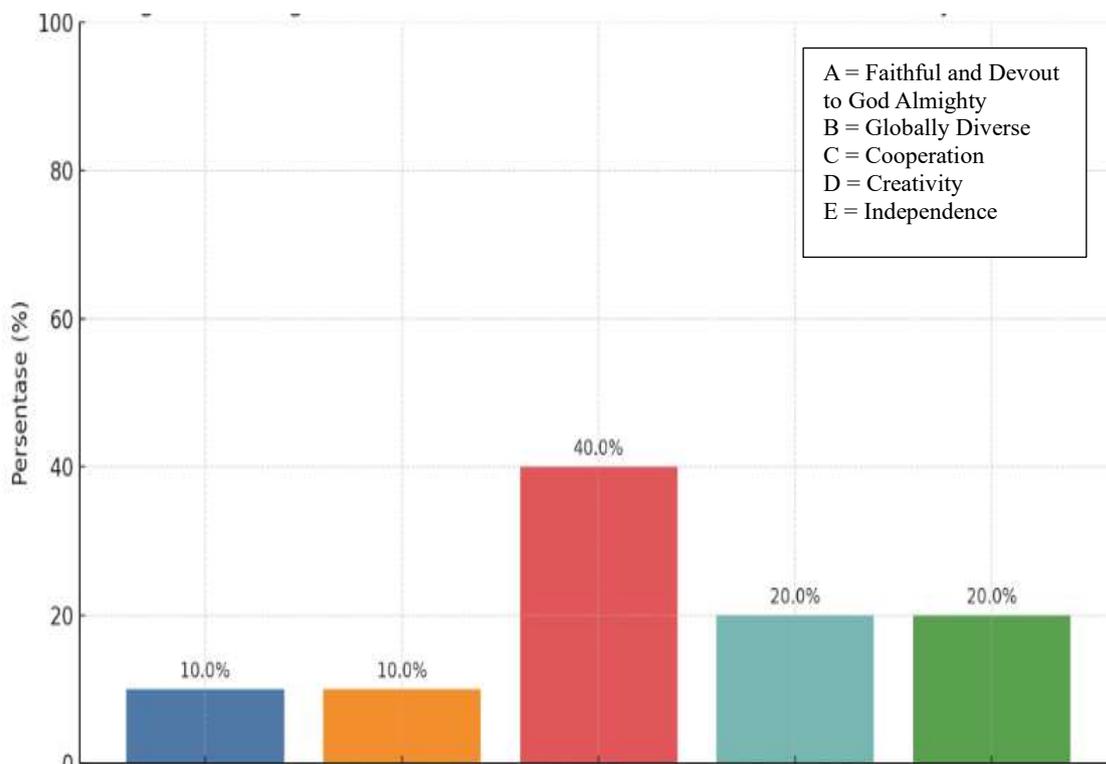


Figure 5. Bar Chart Based on Pancasila Student Profile Indicators

**Local Wisdom-Based Items: Baayun Maulid**

Physics science literacy items derived from the Baayun Maulid tradition in South Kalimantan provide an interesting example of how local culture can be integrated into science learning. Baayun Maulid is a Banjar community tradition held to commemorate the birth of Prophet Muhammad SAW. In this event, children or babies are gently swung while sholawat (praises) are recited, accompanied by traditional musical instruments such as the rebana. This tradition is unique because it contains not only religious values but also social and cultural significance. The activity is usually performed collectively, demonstrating community togetherness and cohesion. This is a feature rarely found in other regions, making it a distinctive characteristic of South Kalimantan.

From a scientific perspective, the swinging motion of children in this tradition can be linked to the concept of harmonic motion in physics. The swings move back and forth regularly and can be analyzed in terms of period, frequency, or the length of the swing rope. This allows students to learn about pendulum motion. Meanwhile, the rebana, which is played to accompany the sholawat, can serve as an example to understand waves and sound. When the rebana is struck, its membrane vibrates and produces sound that propagates through the air. Students can study how sound is produced, what affects its volume, and how the shape of a musical instrument influences the type of sound it generates. The advantage of local wisdom-based items is that they make learning more relevant to students' daily lives. Students do not merely memorize formulas but also understand how physics exists within traditions they may often observe. Moreover, these items help preserve local culture and foster pride in their region. Students are also encouraged to think critically as they connect local wisdom with scientific concepts.

**Implications for Practice**

The findings of this study provide several important implications for educational practice. For teachers, the validated instrument can be applied as an alternative tool to assess students' scientific literacy while simultaneously embedding local cultural values and strengthening character education in line with the Pancasila Student Profile. For schools,

adopting this instrument may enhance the quality of assessment systems by making them more contextual, culturally relevant, and aligned with the Merdeka Curriculum. For media developers, the results encourage the innovation of digital or technology-based versions of the instrument to support flexible, engaging, and scalable implementation. At the policy level, this instrument can serve as a reference for integrating cultural wisdom into national assessment practices, thereby enriching the Minimum Competency Assessment (AKM) framework with contextual and character-based dimensions. More broadly, the study recommends the wider application of such culturally integrated instruments across diverse regions and subjects to strengthen the relevance and equity of science education in Indonesia.

## CONCLUSION

The study demonstrates that the developed scientific literacy instrument on harmonic oscillation topics, integrating Baayun Maulid local wisdom and the Pancasila Student Profile, meets the criteria of a high-quality evaluation tool. Through design validation, pilot testing, and large-scale field testing, the instrument was refined to 10 valid, reliable, and appropriately discriminating items, confirming its feasibility for assessing students' scientific literacy in a contextual and culturally relevant manner. Nevertheless, the study has certain limitations, including its focus on a single physics topic, the use of a sample limited to 97 students from three senior high schools in Banjarmasin, the restricted timeframe that prevented longitudinal evaluation, and the reliance on multiple-choice items with reasoning as the primary assessment format. These boundaries may limit the generalizability of the findings but also provide opportunities for further research to broaden the scope of the instrument, test it with more diverse populations, and explore alternative or complementary assessment models. Future research is recommended to address these aspects, while teachers and practitioners are encouraged to implement this instrument in classroom assessments to foster meaningful and culturally embedded evaluation. The development of a digital version is also suggested to enhance accessibility and align with technology-enhanced learning practices.

## RECOMMENDATION

Based on the findings of this study, several recommendations can be proposed for future research and practice. First, further studies are recommended to expand the scope of the scientific literacy instrument by applying it to other physics topics or different science disciplines, in order to enhance its generalizability and applicability. Second, future research should involve a larger and more diverse sample across different regions to examine the consistency of the instrument's psychometric properties in varied educational contexts. Third, longitudinal studies are suggested to investigate the effectiveness of the instrument in monitoring the development of students' scientific literacy over time. Fourth, the integration of local wisdom could be enriched by incorporating other regional cultural practices, allowing comparative studies between different cultural contexts. Finally, future research may explore the development of digital or computer-based versions of the instrument to support technology-enhanced assessment and align with current trends in digital learning and assessment systems. Potential barriers such as limited student familiarity with contextual problems, variations in cultural background, and constraints in school assessment practices should also be considered and addressed in subsequent studies.

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### AUTHOR CONTRIBUTIONS STATEMENT

This study applies the Contributor Roles Taxonomy (CRediT) to describe the contributions of each author as follows:

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Dewi Dewantara	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓			✓
Mustika Wati		✓				✓		✓	✓	✓	✓	✓		
Nadia Rezka Maulida	✓		✓	✓			✓		✓	✓				✓
Sri Hartini				✓		✓			✓		✓			
Surya Haryandi					✓		✓			✓		✓		

C : Conceptualization      I : Investigation      Vi : Visualization  
 M : Methodology          R : Resources          Su : Supervision  
 So : Software              D : Data Curation      P : Project administration  
 Va : Validation            O : Writing - Original Draft      Fu : Funding acquisition  
 Fo : Formal analysis      E : Writing - Review & Editing

### CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest

### INFORMED CONSENT

We have obtained informed consent from all individuals included in this study.

### ETHICAL APPROVAL

The research involving human participants was conducted in accordance with all relevant national regulations and institutional policies and followed the principles of the Helsinki Declaration. Ethical approval for this study was obtained from the relevant institutional review board or equivalent ethics committee of the authors' institution.

### DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, D. Dewantara, upon reasonable request. The data contain information that could compromise the privacy of research participants and are therefore not publicly available.

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