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Scientific Literacy Skills Based on Local Wisdom and Pancasila Student Profile: Supporting Quality Education (SDG 4)

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ABSTRACT

Objective: *Scientific literacy is an essential competency for students in responding to rapid developments in science and technology. However, students' scientific literacy skills in Indonesia remain below international standards, indicating the need for contextual learning approaches. This study aims to analyze the scientific literacy profile of senior high school students based on local wisdom and the Pancasila Student Profile. This study contributes to achieving Sustainable Development Goal (SDG) 4 by supporting quality education through contextual and meaningful science learning.* ***Method:*** *A descriptive quantitative approach using a survey method. The participants consisted of 202 senior high school students from Balangan and Tabalong Regencies, South Kalimantan, Indonesia. Data were collected using a scientific literacy instrument consisting of 16 multiple-choice questions integrated with local wisdom and Pancasila Student Profile values. The collected data were analyzed using the Rasch Model with the assistance of the Winstep application to determine students' ability levels, item difficulty, and instrument reliability.* ***Results:*** *The results showed that students' scientific literacy skills were categorized as very high (8.91%), high (23.27%), sufficient (31.68%), low (28.71%), and very low (7.43%). The instrument demonstrated adequate reliability with a person reliability value of 0.69 and Cronbach's alpha value of 0.75. These findings indicate that most students have moderate scientific literacy abilities, but further improvement is required.* ***Novelty:*** *To provide a novel contribution by assessing physics scientific literacy using instruments integrated with local wisdom and the Pancasila Student Profile, providing a contextual approach to supporting quality science education aligned with SDG 4.*

INTRODUCTION

Qualified and competent individuals who are able to compete globally in terms of knowledge, expertise, and skills represent essential human resources required in the 21st century (Abdullah, 2023). One of the fundamental abilities that students need to develop in responding to current technological advancements is scientific literacy. Scientific literacy includes several scientific competencies, including the ability to explain scientific phenomena, interpret scientific data and evidence, and evaluate and design scientific investigations (OECD, 2023).

Students' scientific literacy skills are commonly assessed through the Programme for International Student Assessment (PISA). This international assessment evaluates students' competencies in reading, mathematics, and science, with scientific literacy emphasizing students' ability to understand, interpret, and engage with science-related issues (OECD, 2023). According to OECD (2023), PISA was last conducted in 2022 and is implemented every three years to measure students' competencies in various domains. Indonesia has participated in PISA since 2000. In the scientific literacy domain, Indonesia ranked 66th out of 81 participating countries, achieving a score of 383, indicating that Indonesian students' scientific literacy performance remains below the international average (Nur'aini et al., 2021).

Scientific literacy is an essential competency for students because it enables them to understand and investigate their surrounding environment, apply scientific reasoning in decision-making processes, and solve complex problems in a world increasingly influenced by advancements in science and technology. Therefore, assessing students' scientific literacy levels is crucial to identify their current abilities and provide evidence-based strategies for improving science education. Several studies have investigated students' scientific literacy through various assessment approaches; however, limited studies have examined scientific literacy using physics instruments based on local wisdom and the Pancasila Student Profile, particularly in the context of South Kalimantan, especially in Balangan and Tabalong Regencies.

This study aims to analyze the scientific literacy profile of senior high school students in physics using assessment instruments integrated with local wisdom and the values of the Pancasila Student Profile. The assessment was conducted among students in Balangan and Tabalong Regencies by analyzing the distribution of students' abilities and the difficulty levels of test items using the same measurement scale through Variable Maps. The findings are expected to provide insights into students' scientific literacy characteristics and support the development of contextual science learning approaches aligned with the goals of quality education.

RESEARCH METHOD

The method used in this study is a quantitative descriptive method with a purposive sampling technique. This research is a survey type, where data is collected using a test instrument sheet. The population in this study was Balangan Regency dan Tabalong Regency Senior High School. The samples were selected randomly to represent the two districts. A total sample of 202 students from 3 schools who had studied particle dynamics material became the subjects of this study. The time used in data collection and test implementation was from February to March 2024. The instrument used included 16 multiple-choice questions designed around scientific literacy, local wisdom, and the Pancasila student profiles. The students' test results were analyzed using the Rasch model through the Winstep program to determine the logit value. The program outputs include a variable map, reliability measures, summary statistics, and person logit (person measure) values. Data analysis in this study is descriptive statistics used to analyze students' answers in answering the given question instruments. Each number is obtained through an assessment of the answers given. To measure students' scientific literacy, they will be given a test question. The questions consist of multiple choices and the following are the scoring guidelines used.

Table 1. Scoring guidelines

Multiple Choice	Reason	Score
Right	Right	3
Right	Less	2
Right	Wrong	1
Wrong	Wrong	0

Description:

Correct = Students can explain their reasons
correctly and precisely Less = Students explain
their reasons but not accurately
Wrong = Students cannot explain their reasons correctly

Students' scientific literacy abilities can be identified through the person measure value obtained from the Rasch model output. The person measure represents students' ability levels in responding to test items and provides information regarding the distribution of students' scientific literacy competencies. Based on the person measure classification, students' abilities can be categorized into five levels: very high, high, moderate, low, and very low (Nugraha & Umam, 2023).

In this study, the standard deviation value (SD) was 0.53, while the mean person measure (M) was -0.46. The consistency of students' responses and the quality of the measurement process were evaluated using the Person Reliability value in the Rasch model output. Person Reliability indicates the consistency of respondents' responses when completing the assessment instrument (Purwana et al., 2020). Furthermore, the reliability of test items in Rasch-based instruments can be evaluated through the Cronbach's alpha value, which represents the overall internal consistency of the instrument (Purwana et al., 2020).

RESULTS AND DISCUSSION

Results

Student science literacy ability based on maps variables (wright map) and answer consistency categories (person reliability)

Variable maps (Wright maps) illustrate the distribution of students' abilities (person measures) and the difficulty levels of test items on the same measurement scale. Figure 1 presents the distribution of students' ability levels, which is one of the outputs generated from the Winstep program in Rasch analysis (Huda & Rohaeti, 2021). The Wright map provides a visual representation of the relationship between respondents' abilities and item difficulties, allowing researchers to identify whether test items are appropriate for measuring students' competencies. The map categorizes students' ability levels from very high at the upper level to very low at the lower level based on the measured logit scale (Nugraha & Umam, 2023).

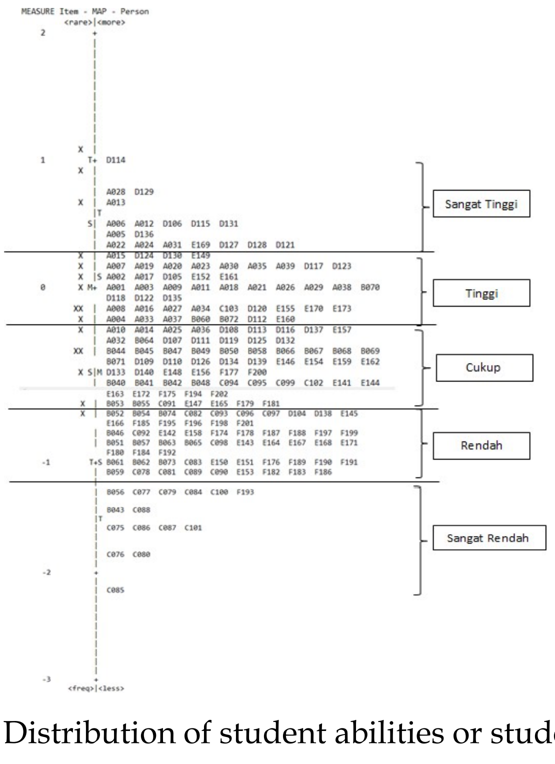

Figure 1. Distribution of student abilities or student ability

Based on Figure 1, the percentage of overall scientific literacy abilities of students in Balangan and Tabalong Districts is show in Table 2.

Table 2. Percentage of student ability on maps variables

Category	School	Sum	Total	Percentage
Very high	SMAN 2 Paringin	9		
	SMAN 1 Tanjung	8	18	8.91%
	SMAN 1 Juai	1		
High	SMAN 1 Tanjung	26		
	SMAN 2 Paringin	10		
	SMAN 1 Juai	7	47	23.27%
	SMAN 1 Kelua	3		
	SMAN 3 Tanjung	1		
Enough	SMAN 1 Kelua	18		
	SMAN 2 Paringin	16		
	SMAN 1 Juai	13		
	SMAN 2 Juai	7	64	31.68%
	SMAN 1 Tanjung	5		
	SMAN 3 Tanjung	5		
Low	SMAN 2 Juai	21		
	SMAN 1 Kelua	12		
	SMAN 1 Juai	12	58	28.71%
	SMAN 3 Tanjung	11		
	SMAN 2 Paringin	2		
Very low	SMAN 3 Tanjung	13		
	SMAN 1 Kelua	2	15	7.43%
	Total		202	100.00%

Districts meet the normal curve distribution. A normal curve is a curve that has a value that is quite more than a very high, high, low or very low value (Widhiarso, 2010). The shape of the normal curve in this study is as Figure 2.

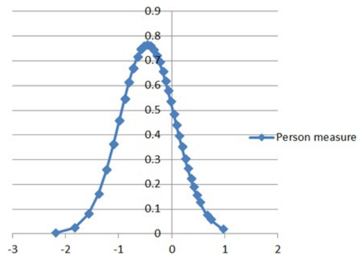

Figure 2. Science literacy ability curve based on person measure

Students' scientific literacy skills were assessed based on three scientific literacy indicators: explaining scientific phenomena, interpreting scientific data and evidence, and evaluating and designing scientific investigations (MOJE et al., 2004). The research instrument consisted of 16 items, with six items measuring the ability to explain scientific phenomena, six items assessing the interpretation of scientific data and evidence, and four items evaluating and designing scientific investigations (Rosana et al., 2020). Based on the categorization of person measure values, students with logit values above 0.3 were classified into the very high category. A total of 18 students were included in this category, indicating that these students were able to answer scientific literacy questions effectively.

The very high category consisted of students from several schools, including eight students from SMAN 1 Tanjung (code A), nine students from SMAN 2 Paringin (code

D), and one student from SMAN 1 Juai. Interviews with teachers confirmed that students in this category actively participated in learning activities and were among the academically high-performing students. One representative student in this category was student code D114 (Wu, Lo, & Tsai, 2019). Based on the scientific literacy indicators, D114 successfully answered three questions correctly in explaining scientific phenomena with appropriate reasoning. In interpreting scientific data and evidence, the student answered five questions correctly with accurate explanations. However, in evaluating and designing scientific investigations, the student answered three questions correctly, but only one response was supported by appropriate reasoning (Zhang, Liu, & Feng, 2023). This indicates that although the student demonstrated excellent scientific literacy ability, the ability to provide scientific justification in investigation-related tasks still requires improvement.

Students classified in the high category consisted of 47 students, with logit values ranging from -0.2 to 0.3. These students came from SMAN 1 Tanjung, SMAN 1 Kelua, SMAN 2 Paringin, SMAN 1 Juai, and SMAN 3 Tanjung. Similar to the very high category, teacher interviews indicated that students in this group demonstrated active participation and strong academic performance (Widaningsih, 2022). One representative student, A015, was able to answer scientific literacy questions correctly; however, the student still experienced difficulties in providing appropriate reasoning, particularly in explaining scientific phenomena and evaluating scientific investigations. This finding suggests that students' conceptual understanding has developed, but their ability to construct scientific arguments remains incomplete (Yao, Guo, & Neumann, 2016).

The sufficient category included 64 students with average logit values ranging from -0.7 to -0.2. Students in this category demonstrated moderate scientific literacy abilities. One representative student, F181, was able to answer several questions correctly; however, many responses were not supported by scientifically appropriate explanations. In the indicator of interpreting scientific data and evidence, F181 answered three questions correctly, but only one response contained an accurate reason. Meanwhile, in evaluating and designing scientific investigations, the student answered four questions correctly, with two responses accompanied by appropriate reasoning. These results indicate that students in the sufficient category have developed basic scientific literacy skills but still require improvement in providing scientific explanations and arguments.

The low category consisted of 58 students with logit values ranging from -1.2 to -0.7. This category was dominated by students from SMAN 2 Juai. One representative student, F186, demonstrated limited scientific literacy skills. Although the student was able to answer several questions correctly, the reasoning provided was inaccurate across all scientific literacy indicators. This condition indicates that students at the low level may recognize certain scientific concepts but have difficulties in explaining phenomena, interpreting evidence, and evaluating scientific investigations.

The very low category consisted of 15 students, mainly from SMAN 3 Tanjung (13 students) and SMAN 1 Kelua (2 students), with logit values below -1.21. One representative student, C085, showed very limited scientific literacy skills. The student was only able to answer one question correctly in explaining scientific phenomena and interpreting scientific data and evidence, but the responses lacked appropriate reasoning. Furthermore, the student was unable to answer the investigation-related questions correctly. These findings indicate that students in the very low category require stronger learning support, particularly in developing reasoning skills and applying scientific concepts in contextual situations.

The consistency of students' responses was evaluated through the person reliability value obtained from the Rasch model output. Person reliability indicates the consistency of respondents' answers when completing the assessment instrument (Purwana et al., 2020). Furthermore, reliability analysis using Rasch-based instruments provides information regarding the quality and consistency of measurement results (Huda & Rohaeti, 2021). The results showed that the person reliability value was 0.69, which falls within the sufficient category (0.67–0.80). This indicates that the consistency of responses from senior high school students in Balangan and Tabalong Regencies was relatively acceptable, although further improvement is required to obtain stronger measurement consistency (Purwana et al., 2020).

Item difficulty level and overall instrument reliability (Cronbach's Alpha)

In the Winstep output there is also a maps variable (wright map), which describes the distribution map of the level of difficulty of the questions on a uniform scale. Figure 2 shows the distribution of the level of difficulty of the items obtained from the wright map output in Winstep.

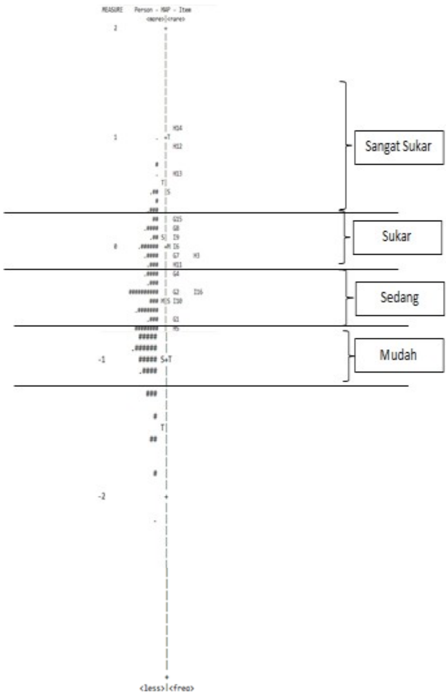

Figure 3. Distribution of item difficulty levels

Figure 3 presents the Wright map illustrating the difficulty levels of the test items. Each item is coded based on the scientific literacy indicators, namely code G for explaining scientific phenomena, code H for interpreting scientific data and evidence, and code I for evaluating and designing scientific investigations. The difficulty levels of the items are arranged from the most difficult to the easiest based on their logit values. The items with the highest difficulty levels were H14, H12, and H13. All of these difficult items belong to code H, which represents the competency of interpreting scientific data and evidence. These items could only be solved by students with very high scientific literacy abilities, consisting of 18 students (8.91% of the total participants).

The difficult category consisted of items G15, G8, I9, I6, G7, H3, and H11, with most items representing the competency of explaining scientific phenomena. Students who were able to solve these items were mainly those categorized as having high scientific literacy abilities, consisting of 47 students. Meanwhile, items G4, I16, G2, I10, and G1 were categorized as having moderate difficulty levels and could generally be answered by students with sufficient scientific literacy abilities, consisting of 64 students. Item H5 was categorized as an easy item because it could be answered correctly by 187 students. However, 15 students still experienced difficulties in answering this item, indicating differences in students' conceptual understanding.

The physics scientific literacy instrument based on local wisdom and the Pancasila Student Profile demonstrated consistent measurement results. The person reliability value was categorized as sufficient, while the Cronbach's alpha value reached 0.75, indicating very high internal consistency. This result shows that the developed instrument has good reliability and can produce consistent measurement results when applied repeatedly (Wati et al., 2021). According to Purwana et al. (2020), reliable scientific literacy instruments are important for accurately identifying students' competencies and supporting the evaluation of science learning outcomes.

The difficulty level of an assessment item reflects the complexity of the knowledge and skills required to answer the question. Nugraha and Umam (2023) explained that difficult items generally measure competencies that are unfamiliar or require higher-order thinking processes among students. Therefore, identifying item difficulty through Rasch analysis provides important information for improving assessment quality and ensuring that instruments appropriately measure students' scientific literacy abilities (Purwana et al., 2020).

Based on the Wright map analysis and student ability categorization, the overall scientific literacy ability of students in this study was classified as sufficient. Most students were able to answer the majority of items, although differences were observed in their ability to provide scientific reasoning and explanations. The integration of local wisdom in science learning has been reported as an effective approach to improving students' scientific literacy because it connects scientific concepts with students' real-life experiences (Abdullah, 2023; Ardiansyah & Nur, 2024; Tabun, 2024; Verawati & Wahyudi, 2024).

Furthermore, Zainuri et al. (2024) demonstrated that integrating local wisdom with problem-based learning approaches can improve students' scientific literacy by encouraging contextual problem-solving and scientific reasoning. The implementation of local wisdom is not limited to learning approaches but can also be incorporated into instructional media, including teaching aids, which have been shown to support students' understanding of scientific concepts (Wati et al., 2018). These findings indicate that local wisdom-based learning contributes not only to scientific literacy development but also to students' scientific process skills and other cognitive competencies (Sary et al., 2023; Pieter & Risamasu, 2024; Ibrahim, 2023; Aldian & Wahyudiati, 2024).

The effectiveness of local wisdom integration can be explained by its contextual characteristics, as local phenomena are closely related to students' daily experiences. This connection enables students to construct scientific understanding more easily and develop meaningful learning experiences. Therefore, implementing local wisdom-based approaches in science education can provide broader benefits, not only for improving scientific literacy but also for strengthening students' scientific reasoning and learning outcomes. Future research should expand scientific literacy investigations beyond specific learning materials and include different educational levels to obtain a more comprehensive understanding of students' scientific literacy development.

Discussion

The findings of this study indicate that the scientific literacy abilities of senior high school students in Balangan and Tabalong Regencies are predominantly categorized as sufficient, with only a limited proportion of students reaching very high literacy levels. This condition reflects the ongoing challenges in developing students' ability to explain scientific phenomena, interpret scientific evidence, and evaluate scientific investigations. Scientific literacy is a fundamental competency that enables students to understand scientific concepts and apply scientific reasoning in real-life situations. According to OECD (2023), scientific literacy involves students' ability to engage with science-related issues, interpret evidence, and make informed decisions based on scientific knowledge. Therefore, improving scientific literacy represents an important aspect of achieving SDG 4, which emphasizes equitable access to quality education and the development of meaningful learning competencies.

The integration of local wisdom into scientific literacy instruments provides an important contribution to contextual science learning. The results demonstrate that connecting physics concepts with students' surrounding environments can create meaningful learning experiences and improve students' understanding of scientific phenomena. According to Tabun et al. (2024), contextual learning approaches based on local environments can support students' engagement and strengthen their understanding of learning materials. Similarly, Zainuri et al. (2024) found that integrating local contexts into science learning through appropriate instructional approaches can improve students' scientific literacy skills. These findings indicate that local wisdom-based learning can support SDG 4 by promoting inclusive, relevant, and culturally responsive education.

Furthermore, the reliability analysis shows that the scientific literacy instrument developed in this study provides consistent measurement results, with adequate person reliability and Cronbach's alpha values. The application of the Rasch Model enables researchers and educators to identify students' ability distributions and determine the difficulty level of assessment items more accurately. According to Purwana et al. (2020), reliable assessment instruments are essential for evaluating students' scientific abilities and supporting effective learning improvements. Therefore, the development of scientifically valid assessment tools integrated with local wisdom and Pancasila Student Profile values can contribute to improving the quality of science education and strengthening the implementation of SDG 4 through evidence-based educational practices.

CONCLUSION

Fundamental Finding: This study reveals that the scientific literacy skills of senior high school students in Balangan and Tabalong Regencies are generally categorized as sufficient. The assessment results show that most students have developed basic scientific literacy abilities, but improvements are still needed, particularly in explaining scientific phenomena, interpreting scientific evidence, and evaluating scientific investigations. The integration of local wisdom and Pancasila Student Profile values provides a meaningful approach to measuring and understanding students' scientific literacy development. **Implicatio:** The findings imply that science learning should incorporate contextual approaches that connect scientific concepts with students' real-life environments. Local wisdom-based learning instruments can support teachers in designing more meaningful learning experiences and contribute to SDG 4 by promoting quality, relevant, and inclusive education. **Limitation:** This study has limitations related to the research scope, which only involved senior high school students from

Balangan and Tabalong Regencies. Furthermore, the assessment focused on physics scientific literacy using specific instruments and did not explore other factors influencing literacy development, such as learning motivation, teaching strategies, or students' socioeconomic backgrounds. **Future Research:** Should expand the investigation to different educational levels, learning materials, and geographical areas. Further studies may also integrate qualitative approaches, such as interviews and classroom observations, to obtain deeper insights into students' scientific literacy development and the effectiveness of local wisdom-based learning approaches.

AUTHOR CONTRIBUTIONS

Mustika Wati contributed to the conceptual framework, research design, methodology development, instrument development, data analysis, interpretation of results, and manuscript preparation. **Nur Afifah Azzahra** contributed to literature review, data collection, data analysis support, and manuscript drafting. **Qamariah** contributed to research validation, supervision, interpretation of findings, and critical revision of the manuscript. All authors have reviewed and approved the final version of this submission.

CONFLICT OF INTEREST STATEMENT

The authors confirm that there are no conflicts of interest, either financial or personal, that may have influenced the content or outcome of this study.

ETHICAL COMPLIANCE STATEMENT

This manuscript complies with research and publication ethics. The authors affirm that the work is original, conducted with academic integrity, and free from any unethical practices, including plagiarism.

STATEMENT ON THE USE OF AI OR DIGITAL TOOLS IN WRITING

The authors acknowledge the use of digital tools, including AI-based technologies, as support during the research and writing stages of this article. Specifically, ChatGPT (OpenAI) was used for language refinement, improving manuscript readability, and assisting in academic writing organization. Grammar-checking tools were utilized to improve language accuracy and consistency throughout the manuscript. All outputs generated with digital assistance were critically evaluated, verified, and revised by the authors to ensure academic rigor, research integrity, and ethical standards were maintained. The use of these digital tools did not replace the authors' intellectual contributions in conceptualization, methodology development, data analysis, interpretation of findings, or scientific decision-making. The final responsibility for the accuracy, originality, and integrity of the manuscript rests entirely with the authors.

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