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Profile of Science Literacy in Physics with Local Wisdom and Profile of Pancasila Students

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Abstract

Research on science literacy in South Kalimantan has been conducted in several areas, but has not yet described a representative profile and has not integrated the local context and national character values as a whole. This study aims to map students' science literacy skills using local wisdom-based instruments and the dimensions of the Pancasila Student Profile, a new approach to measuring science literacy. The method used was a descriptive quantitative approach, involving 192 students from eight high schools in the Hulu Sungai Tengah and Hulu Sungai Utara districts. Data were analyzed using the Rasch Model in the Winsteps application to obtain the ability distribution, instrument reliability, and visual mapping via variable maps. The results show that the science literacy skills of students in Hulu Sungai Tengah district are relatively balanced (26.56% in the high category), while in Hulu Sungai Utara district, most are classified as low, with a difference of 5.20% more in the lower category. Logit mapping on variable maps confirmed that the majority of respondents from Hulu Sungai Utara had below-average ability. This research contributes by developing science literacy instruments that are contextual, character-educative, and in accordance with the direction of the Merdeka Curriculum, as well as a basis for designing adaptive and value-based learning strategies.

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INTRODUCTION

21st-century education requires students to have literacy competencies to face global challenges. One crucial form of literacy is science literacy. According to him, science literacy is the ability of learners to relate science knowledge to real-life issues and make science-based decisions responsibly. Science literacy includes critical, creative, collaborative, and communicative thinking skills that are essential in learner development (Savitri et al., 2024)

According to the National Academy of Science (1996 in Dewantari & Singgih, 2020) the skills in science literacy must be instilled early so that students can utilize these skills in their development to make decisions and participate in social life, culture, and economic growth in various aspects of both social life, culture, and economic growth. The younger generation needs science literacy skills because this competency can link human resources

and natural resources in the local area to be managed properly (Fortus et al., 2022; Sari et al., 2023; Sutiani et al., 2021).

Science literacy is an ability that requires several skills and is very important for adolescent children heading towards adulthood, as it can not only support learning in school but also help them prepare for their future as smart, critical, and responsible individuals. Therefore, educators need to assess students' abilities in schools to address shortcomings in their science literacy. According to Fuadi et al. (2020), several factors contribute to low science literacy skills. One is that educators have not been effective in developing science literacy skills.

The causes of low science literacy in some schools include students' lack of understanding of concepts, interest in learning, appropriate learning methods, and misconceptions, as well as argumentation skills (Wulandari et al., 2023; Winarni et al., 2020; Ramli et al., 2022). This greatly affects some science subjects, such as physics. In learning physics, students really need science literacy skills, as these can support the learning process.

In physics learning, science literacy skills are increasingly important because students are required to understand concepts and explain phenomena scientifically. The Merdeka Curriculum is an effort to foster these competencies early on by integrating the values of the Pancasila Student Profile, which includes six main character dimensions: faith and piety, global diversity, mutual cooperation, independence, critical reasoning, and creativity (Harahap, 2023). These values are closely related to the local wisdom that is the cultural and social identity of Indonesian society.

Unfortunately, research by Rahayu et al. (2022) shows that many students do not recognize their local wisdom. This has the potential to erode cultural identity and weaken the integration of character values in education. Learning that incorporates elements of local wisdom has been shown to increase interest in learning and strengthen student character, including in physics learning (Hikmawati et al., 2021; Martawijaya & Hasyim, 2023; Savitri et al., 2024).

Several previous studies have attempted to map students' science literacy skills in South Kalimantan. Wati et al. (2023) conducted a mapping of science literacy among high school students in urban areas, revealing gaps in interpretation and scientific communication. Siswanto et al. (2023) highlighted obstacles to the development of science literacy, including misconceptions about concepts and the limited pedagogical practices of physics teachers. Meanwhile, Isnaniah et al. (2023) developed learning tools to improve science literacy based on fluid dynamics, but have not integrated the dimensions of national character. Different from these studies, this study combines three approaches in an integrated manner: measurement of science literacy with the Rasch Model, integration of local wisdom as a question context, and alignment of instruments with the Pancasila Student Profile as a national character framework. Thus, this study provides new contributions in the form of cross-regional representative measurements and instrument development approaches relevant to the Merdeka Curriculum.

Based on this background, this study aims to determine the science literacy profile of students in two regions of South Kalimantan that have different geographical and socio-cultural characteristics. The instrument used integrates the context of local wisdom and the dimensions of the Pancasila Student Profile in particle dynamics material. The results of this study are expected to serve as the basis for the development of relevant, adaptive, and character-based learning strategies to improve the quality of science literacy at the senior high school level.

METHODS

This study used a quantitative descriptive approach to obtain a picture of the science literacy profile of students in two districts in South Kalimantan: Hulu Sungai Tengah

Regency and Hulu Sungai Utara Regency. Data were obtained through a science literacy test based on the context of local wisdom and the dimensions of the Pancasila Student Profile, focusing on particle dynamics.

The respondents in this study were 192 students from eight state senior high schools (SMAN). Four schools were from Hulu Sungai Utara Regency (coded A, B, C, and D), and four others were from Hulu Sungai Tengah Regency (coded E, F, G, and H). The selection of respondents was carried out using purposive sampling techniques, with consideration of regional representation and suitability to the context of physics learning.

The test instrument was developed by researchers based on science literacy indicators, contextualized with local values , and six character dimensions of the Pancasila Student Profile. The instrument's validation is reported in the article by Wati et al. (2023). The participants' answers were analyzed using the Rasch Model in the Winsteps application, as this model allows the simultaneous mapping of individual abilities and the evaluation of item quality.

The analysis with Winsteps produces several main outputs, including summary statistics, person measures, index separation, person reliability, and variable maps. Person measures show individual abilities in logit units. The category of student abilities is determined based on the average value (mean) and standard deviation, as listed in Table 1.

Table 1 Criteria for student abilities

Logit Person Measure Value	Ability Level
$X \geq M$	High
$X < M$	Low

The separation index is used to assess the extent to which an instrument can distinguish between respondents' abilities. The higher the separation value, the better the instrument's ability to classify respondents. The separation value is calculated using the following formula (Hartatik et al., 2022):

$$H = \frac{[(4 \times Indeks\ Separation) + 1]}{3} \qquad (1)$$

Meanwhile, a person's reliability was calculated using Cronbach's Alpha (KR-20) from the statistical summary output, which reflects the consistency of participants' responses across all items in the instrument. The criteria for categorizing Cronbach's Alpha values can be seen in Table 2.

Table 2 *Cronbach alpha* assessment criteria

Criteria	Category
< 0.5	Low
$0.5 > 0.6$	Medium
$0.6 > 0.7$	High
$0.7 > 0.8$	Very High
> 0.8	Extraordinary

(Faradillah et al., 2021)

In this study, the data analyzed included 191 respondents, consisting of 101 students from Hulu Sungai Tengah Regency and 90 from Hulu Sungai Utara Regency. All analysis results will be explained descriptively to describe the distribution and level of students' scientific literacy abilities based on region and the mapping of the instruments used.

RESULTS AND DISCUSSION

The Rasch model also calculates *Cronbach's Alpha* (KR-20) as an indicator of the instrument's internal consistency. The value of 0.73 obtained is in the high category, indicating that the variance of each item is quite correlated with the entire scale. In the

context of Rasch, the *Cronbach Alpha* value represents the extent to which differences in participant ability levels can explain variations in answers between individuals. The higher the value, the greater the likelihood that the items presented capture real differences between respondents, not simply random factors.

Conceptually, Cronbach's Alpha in the Rasch model is also related to the fit between participants' abilities and item difficulties. When participants with high ability answer difficult items correctly and participants with low ability have difficulty answering easy items, the Alpha value will increase. Therefore, a high reliability value reflects the instrument's efficiency and accuracy in measuring latent variables, in this case, integrated science literacy.

In Rasch modeling, the separation index indicates the instrument's ability to distinguish groups of respondents based on their ability levels. The higher the separation value, the greater the instrument's ability to group individuals into significantly different ability strata.

$$H = \frac{[(4\ x\ 1{,}46) + 1]}{3} = \frac{6{,}84}{3} = 2{,}3$$

This value is then rounded to 2, indicating that the instrument is able to group students into two levels of ability, namely groups with high and low scientific literacy. This is important in the context of education because mapping ability groups allows educators to design more targeted learning interventions.

In a similar study by Mahtari et al. (2024), a separation value of 3 was considered very good because it more sharply differentiated students into three ability levels. Although the separation value in this study was not high, a value of 2 was considered adequate and indicated that the instrument had diagnostic quality suitable for use in the context of early mapping of scientific literacy.

Shows that the variance of participants' abilities is quite detectable by the items in the instrument, although there is still room for improvement in the sensitivity aspect of the instrument to more subtle differences between individuals. Therefore, this instrument can be said to be quite good at detecting the diversity of students' levels of scientific literacy, especially in the context of education that integrates local values and national character.

To obtain a more detailed picture of students' scientific literacy skills, grouping was based on the person measures' results into two categories: high and low. This grouping was then analyzed by school code and administrative area, namely Hulu Sungai Tengah Regency and Hulu Sungai Utara Regency. Table 4 presents the distribution of students by school code category, along with the total and overall percentages.

Based on the results of the person-measure grouping in Table 4, most students in both regions are in the low-science-literacy category. Hulu Sungai Tengah Regency recorded 51 respondents (26.56%), and Hulu Sungai Utara Regency recorded 50 respondents (26.04%). On the other hand, the number of respondents with high abilities was higher in Hulu Sungai Tengah, namely 51 people (26.56%), while Hulu Sungai Utara had only 40 people (20.84%).

This comparison shows that Hulu Sungai Tengah Regency has a more balanced distribution of abilities between the high and low categories, while students with low abilities dominate Hulu Sungai Utara Regency. This inequality is reinforced by the variable maps, which show that most respondents from schools in Hulu Sungai Utara are below the logit average line. This visualization indicates that the abilities of students in the region tend not to reach the expected science literacy standards.

Overall, 52.60% of the total 192 respondents were categorized as low-ability. This finding is in line with national data released by BPS, which noted that the literacy rate of the Indonesian people remains relatively low at 38.10 (Maharani & Hardjati, 2025). Similar results were also reported by Sauqina & Istyadji (2022), who found that students' science literacy completion in Banjarmasin reached only 40.56%.

Table 4 Percentage distribution of science literacy skills in Hulu Sungai Tengah Regency and Hulu Sungai Utara Regency

Category	School Code	Amount	Total	Percentage
High	A	19	51	26,56%
	B	11		
	C	13		
	D	8	40	20,84%
	E	11		
	F	7		
	G	19		
	H	3		
Low	A	4	51	26,56%
	B	17		
	C	12		
	D	18	50	26,04%
	E	19		
	F	17		
	G	5		
	H	9		
Total		192	192	100,00%

This condition indicates pedagogical challenges that require systematic follow-up. The inequality in scientific literacy achievement underscores the importance of teachers and educational units in designing more adaptive learning, especially based on local context and student characteristics. Strengthening efforts can be done through teacher training in scientific literacy, development of teaching tools based on local wisdom, and application of learning approaches that emphasize higher-order thinking skills (HOTS), such as the ability to explain, analyze, and solve problems.

The low scientific literacy skills in this study were reflected not only in errors in answering questions but also in students' inability to explain the conceptual reasons for their answer choices. This indicates weak scientific interpretation, inference, and communication skills (Damarsha et al., 2023). These skills are very important in the context of scientific literacy because they directly relate to explaining scientific phenomena and making evidence-based decisions.

Furthermore, this weakness can be associated with minimal initial knowledge, a lack of content mastery, and a low ability to connect science concepts with real-world situations. Kholiq (2020) stated that physics learning in schools still tends to be oriented toward technical procedures rather than the meaning of concepts and their applications in everyday life. Therefore, scientific literacy needs to be developed systematically through the transformation of a more dialogical, reflective, and contextual learning approach in accordance with the values of the Pancasila Student Profile.

Figure 1 is a Wright Map, or variable map, of the results of Rasch analysis that displays the distribution of student abilities (Person) on the left side and the level of difficulty of the questions (Item) on the right side. The logit scale in the middle is used as a common measure that shows ability and difficulty equally. In this map, the higher the position on the logit scale, the greater the participant's ability or the more difficult the item.

The mapping results show that most participants are displayed in the logit range of -2 to -4, which is below the mean line (logit 0.0). This indicates that most respondents have low science literacy skills. Even many participants from schools with the initials B, C, D, F, G, and H appear dominant in the logit area of -3 to -5. This distribution is consistent with the

statistical summary, which shows that more than 52% of respondents are at low ability levels.

Data analysis using the Rasch Model produces summary statistics that include important parameters, such as mean, standard deviation, person reliability, Cronbach's alpha, separation index, and logit measure values. These parameters provide an overview of the instrument's quality and the overall distribution of student abilities. This information is presented in Table 3.

Table 3 Summary statistic

Aspect	***Logit***	**Description**
SD	0.90	-
Mean	3	-
Person Reliability	0.68	Medium
Cronbach's Alpha	0.73	High
Measure	3	Mean
Separation Index	1.46	-

Table 3 presents the results of the instrument reliability analysis using the Rasch model. The standard deviation (SD) of 0.90 and a mean of 3.00 indicate a fairly even distribution of data. The person reliability value of 0.68 falls into the medium category, while the Cronbach's Alpha of 0.73 is categorized as high, indicating good internal consistency of the instrument. The measure value of 3.00, which corresponds to the mean, confirms that the distribution's central point lies at this logit level. Meanwhile, the separation index of 1.46 is classified as moderate, meaning that the instrument is reasonably capable of distinguishing respondents' ability levels, although further improvement is needed to achieve stronger separation.

This finding is in line with the research of Purwana & Rusdiana (2021), which states that if the distribution of respondents is predominantly below the average logit, then their scientific literacy skills are classified as low. A similar thing was also stated by Gunawan et al. (2023), that a logit of 0.0 can be used as a threshold between participants with basic abilities and participants who begin to show higher conceptual mastery.

The Wright Map in Figure 1 displays the distribution of persons (respondents) and items on a single logit scale. Single letters A–H represent persons, while H followed by a number (H1–H16) represents items. Based on the map, all persons are located within the logit range of 0 to –5, and no respondents are positioned in the positive logit range (+1 to +3). This indicates that, overall, the respondents' ability levels are below the difficulty levels of the items.

In contrast, the items are spread across the logit range from -1 to +3, with some items (e.g., H12, H13, and H14) appearing above +2 logits, indicating relatively high levels of difficulty. This distribution demonstrates that most items are more difficult than the average ability of the respondents. Consequently, there is a misalignment between the person distribution and the item difficulties, suggesting that the majority of respondents are not yet able to respond to the more difficult items successfully.

These findings highlight the need for targeted learning strategies or interventions to improve respondents' abilities, thereby shifting their distribution toward the positive logit scale and achieving a better balance with item difficulty. To avoid confusion in subsequent analyses and interpretations, it is recommended to use different notations—for instance, **P1–P22** for persons and **I1–I16** for items—so that respondents and items can be clearly distinguished. The variable map is shown in Figure 1.

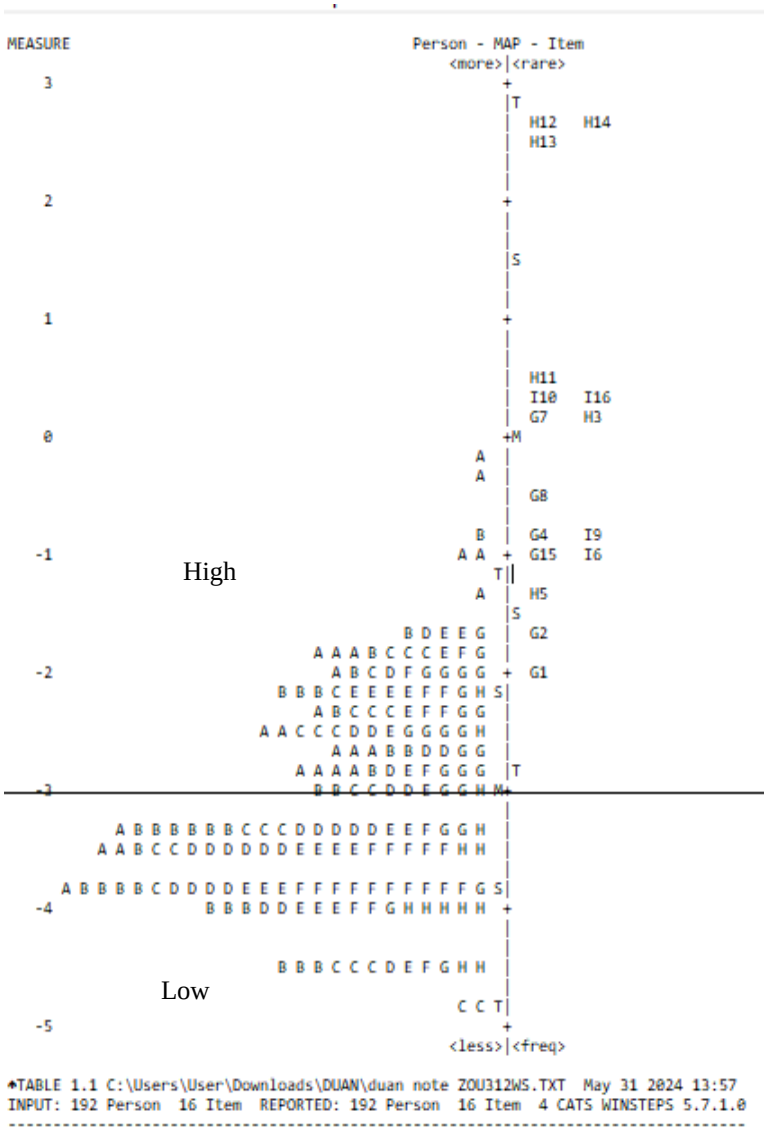

Figure 1 Maps of the Variables

Figure 1 shown is the output of a Rasch analysis from the WINSTEPS software in the form of a Person-Item Map (or Wright Map). This map visualizes the position of respondent ability (person) and item difficulty (item) on the same logit scale. The vertical axis represents the logit measure, ranging from +3 (high ability/difficulty) to -5 (low ability/difficulty). On the left side, letters such as A, B, C, and so on represent respondents. The higher their position, the higher their ability, while respondents positioned lower have lower ability. On the right side, codes such as H12, H14, G7, and others represent test items with their respective levels of difficulty. Items at the top are relatively difficult, while those at the bottom are easier. The midpoint (around zero logits) indicates the average item difficulty. From the distribution in the figure, it can be seen that most respondents are concentrated at the low to medium ability levels (around -2 to -4 logits), while the items are spread from easy to relatively difficult levels. This shows an imbalance: most low-ability respondents are facing items that are more difficult than their ability, which may make answering them challenging. Thus, this map shows that the items are generally moderate to difficult, while participants with low ability make up the majority of the respondents. This information is useful for evaluating whether the items are already

appropriate for the respondents' ability levels or need adjustment to balance the distribution better.

This pattern indicates that most students have not mastered more complex scientific literacy skills, such as explaining scientific phenomena, evaluating scientific arguments, and applying concepts in real-life contexts, as explained by the OECD (2023) in the PISA scientific literacy framework.

This low achievement also indicates that most participants may not be accustomed to the type of question that requires reflective and integrative thinking. As noted by Damarsha et al. (2023), failure to answer questions is not only due to ignorance but also to a lack of ability to explain the reasons for the correct answer choices.

Furthermore, the fact that schools in Hulu Sungai Utara Regency (such as schools A, B, and D) dominate the lower logit area reflects the inequality in scientific literacy achievement across regions. This reinforces the importance of a contextual, wisdom-based learning approach that bridges scientific concepts with students' social and cultural realities (Anzelina, 2023; Dini et al., 2025; Sugiantoro et al., 2024).

Several factors contribute to this low scientific literacy competency. Internal factors include (1) low numeracy skills, (2) limited prior knowledge, (3) weak mastery of content, (4) lack of skills in connecting concepts with real-life contexts, and (5) the level of difficulty of questions that exceeds students' cognitive readiness. In addition, external factors such as less innovative learning approaches, minimal literacy programs in schools, and a lack of supporting learning media also strengthen these findings (Siswanto et al., 2023). Siswanto et al. (2023) even emphasized that the use of traditional, non-contextual learning models makes science learning less meaningful and less effective.

In response to these conditions, the government has launched various literacy-strengthening programs, including the Science Literacy Profile and the implementation of the Pancasila Student Profile. The science literacy program from an early age is expected to instill critical thinking skills, logical reasoning, and scientific behavior needed in everyday life. On the other hand, the Pancasila Student Profile program not only aims to shape the character of students who are faithful, independent, and cooperative, but also equips students with the ability to think globally and act locally (Farhah et al., 2024)

One of the strategic approaches raised in this study is value-based and locality-based science literacy, namely learning that not only teaches science concepts but also instills character and builds relevance to local wisdom inherent in students' lives. This approach is very much in line with the direction of the Independent Curriculum policy, which emphasizes differentiated and project-based learning and the strengthening of the dimensions of the Pancasila Student Profile, including critical reasoning, independence, and global diversity (Farhah et al., 2024).

The integration of local wisdom into science learning serves as a bridge between abstract concepts and social reality. As Anzelina (2023) stated, local wisdom-based learning enables students to understand science through the contexts they encounter every day, such as farming culture, traditional irrigation systems, and local natural phenomena. This not only strengthens mastery of concepts but also fosters a sense of ownership of the knowledge learned.

In addition, this approach encourages reflective, transformative learning, where students are not only recipients of information but also active agents who can link science to environmental, social, and moral challenges. The assessments carried out in this study, which include character indicators such as responsibility and concern for the environment, are concrete examples of how scientific literacy instruments can be designed to not only measure cognition but also shape character.

Another implication is the importance of increasing teachers' capacity to design contextual learning and assessment. Teachers need to be provided with training on how to design HOTS questions based on local context and Pancasila Student Profile values so that

learning does not get caught up in procedural routines but is able to build students' critical and social awareness (Kholiq, 2020; Ramadhani, 2024; Siswanto et al., 2023).

Based on the research findings and pedagogical implications described, several strategic recommendations can be implemented to improve students' scientific literacy in context and with character. First, teachers need to be encouraged to develop assessments and teaching tools that integrate local contexts and the values of the Pancasila Student Profile. Scientific literacy questions that raise regional phenomena, such as agricultural culture, local traditions, or environmental problems, can increase the relevance of learning and student engagement. In addition, applying a project-based learning model that emphasizes collaboration, critical reasoning, and problem-solving will encourage the development of higher scientific literacy competencies. Second, at the school level, there needs to be regular teacher training on developing locality- and character-based literacy instruments, as well as on forming learning communities to share best practices among educators. Cross-subject collaboration also needs to be improved in the design of thematic modules that reflect a holistic, integrative approach. Third, curriculum developers and education offices are advised to systematically compile locally based science literacy learning guidelines, provide a platform for sharing digital teaching materials, and offer policy support that encourages learning innovation in the regions. Finally, for education researchers, further studies are needed on the effectiveness of value-based and locality-based approaches to improving scientific thinking skills, as well as on the development of diagnostic instruments that can specifically map students' weaknesses in scientific literacy. With the synergy among these education actors, strengthening scientific literacy can be done sustainably, not only on the cognitive side but also on the affective, social, and cultural sides of students.

Thus, scientific literacy grounded in values and locality is not only a pedagogical approach relevant to the needs of the times but also a transformational strategy to form students who are not only academically intelligent but also have a character rooted in local culture and are ready to face global challenges.

CONCLUSION

This study shows that students' scientific literacy skills in Hulu Sungai Tengah and Hulu Sungai Utara Districts remain relatively low, with more than 52% of respondents in the low category. Analysis using the Rasch Model shows that the developed instrument has quite good quality in distinguishing the level of student ability. The disparity in achievement between regions and the low ability to interpret and connect with the local context are the main factors. The integration of scientific literacy with the values of the Pancasila Student Profile and local wisdom has proven relevant for strengthening character while improving the quality of physics learning at the high school level. The integration of local wisdom and the Pancasila student profile can connect students' scientific knowledge to solutions to life problems learned in class. In addition, implementing this can help teachers create contextual and meaningful learning strategies.

Other implications. First, teachers need to be encouraged to develop assessments and teaching tools that integrate local contexts and the values of the Pancasila Student Profile. Second, at the school level, there needs to be regular teacher training on developing locality-based and character-based literacy instruments, as well as on forming learning communities to share best practices among educators. Third, curriculum developers and education offices are advised to systematically compile locally based science literacy learning guidelines, provide a platform for sharing digital teaching materials, and offer policy support that encourages learning innovation in the regions. Finally, for education researchers, further studies are needed on the effectiveness of value-based and locality-based approaches to improving scientific thinking skills, as well as on the development of diagnostic instruments that can specifically map students' weaknesses in scientific literacy.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

AUTHOR CONTRIBUTIONS STATEMENT

All authors played an active role and were involved at every stage of preparing this article, from conceptualizing the idea and collecting data to implementing the activities, analyzing the results, and writing the manuscript. The authors also jointly carried out revisions and approved the final version of the article for publication.

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