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Integrated Science Learning *Webbed* Type in Permaculture Theme and *BRADeR* Model to Enhance Science Literacy Competence of Junior High School Students

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ABSTRACT

Objective: This research aims to assess the scientific literacy of State Junior High School 1 Ngoro students in integrated science learning using the webbed type with a permaculture theme and the *BRADeR* model. **Method**: This descriptive quantitative study involves 80 students from State Junior High School 1 Ngoro: 16 from class IX-A (limited trial) and 64 from IX-B and IX-C (broader trial). Data collection was conducted using a science literacy competence test instrument consisting of 10 essay questions designed according to three dimensions of scientific literacy proficiency. The validity assessment by three experts showed that 9 out of 10 questions scored an average of 4, categorizing them as "very valid," while 1 question was also deemed "very valid." The reliability assessment using Cronbach's Alpha indicates good dependability. Data analysis utilized inferential statistics to assess the viability of webbed-type integrated science learning on permaculture and the *BRADeR* model in improving students' science literacy. **Results:** Findings indicate a notable enhancement in science literacy, presenting a mean n-gain of 0.73, which is categorized as high. The most significant enhancement was in articulating scientific phenomena, next was experimental design and data analysis. A moderate enhancement was observed in investigating, applying, and evaluating scientific knowledge for decision-making. **Novelty:** This research examines improvements in science literacy and emphasizes the need for multimedia and multimodel approaches through integrated science learning using the webbed type and *BRADeR* model.

INTRODUCTION

Scientific literacy is gaining significance in aiding people to comprehend different natural occurrences, technological advancements, and societal challenges on a global scale. Nonetheless, research shows that students' levels of scientific literacy are still low. Numerous students struggle to understand and utilize basic scientific principles in practical scenarios (Putri et al., 2020). Moreover, the absence of critical and analytical thinking hinders their capacity to relate acquired knowledge to daily challenges (Nurfadhilah et al., 2023). Conventional teaching methods, combined with the restricted application of innovative techniques such as inquiry-based learning and experiments, also hinder scientific literacy growth. This emphasizes the necessity for enhancements in science education to improve students' scientific literacy abilities, allowing them to more effectively navigate future developments in science and technology.

The transformations in the 21st century, distinguished by the progress of information and communication technology, have created complexities that require individuals to master the 4C skills (Communication, Collaboration, Critical Thinking, and Problem-

Solving, Creativity, and Innovation) (Saphira et al., 2022; Saphira & Prahani, 2022). Science literacy is a crucial competence that enables students to understand natural phenomena, identify scientific questions and inquiries, and derive inferences grounded in empirical evidence (OECD, 2023). Education holds a crucial function in developing science literacy competence, which is recognized as one of the essential competencies in the *Merdeka Belajar* (Fatmawati, 2024; Juniawan et al., 2023), in alignment with the Regulation of the Minister of Education and Culture No. 5 of 2022 regarding Graduate Competency Standards is the minimum criteria that graduates must achieve at a certain level of education.

The PISA 2025 scientific framework delineates the essential proficiencies that should be cultivated through science instruction; these are important for the younger generation to understand, appreciate, and apply scientific knowledge in decision-making and evaluate the benefits and risks of using science and technology. Thus, it is hoped that students will develop science literacy competence, enabling them to become the golden generation of the 21st century, skilled in knowledge and capable of applying science as a solution to various everyday problems. The level of science literacy in Indonesia remains below standard, with a mean PISA score of 383 in 2022, significantly below the OECD average score of 489. Additionally, there are gaps in science education that affect students' science literacy competence (Yusmar, 2023). Conventional science education tends to focus on memorizing theoretical knowledge without encouraging the comprehension of science applications in daily life, leading to neglecting process and attitude aspects in science (Assem et al., 2023; Jones, 2025; Li et al., 2023; Thapaliya & Luitel, 2025). As a result, students struggle to comprehend scientific concepts holistically and are more inclined to memorize rather than utilize the knowledge they have acquired.

The low science literacy among students is attributed to weak reading and comprehension skills and a deficiency in interest and reading habits. Low motivation to learn is also a consequence of the inadequate implementation of science literacy competency tests (Hakim et al., 2022). Observations at State Junior High School 1 Ngoro indicate that students' science literacy competence is still low (Figure 1), as evidenced by their limited ability to explain scientific phenomena and effectively apply scientific information for informed decision-making (Fuadi, 2020).

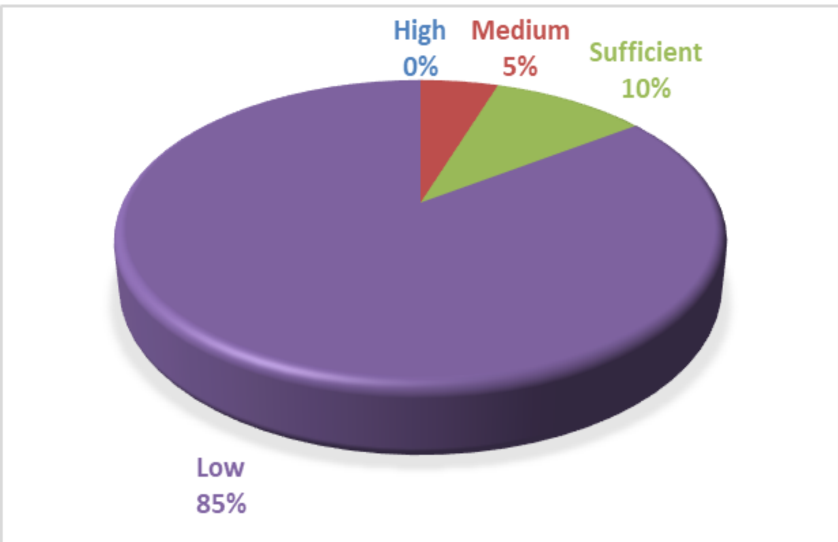


Figure 1. Students' science literacy competence at State Junior High School 1 Ngoro.

Innovations in science education are necessary to enhance science literacy competence that supports learning outcomes. One strategy that can be implemented is designing integrated science learning using the webbed type with a permaculture theme, employing the *BRADeR* model to train students' science literacy competence. The integrated learning model allows students to seek and discover concepts holistically and authentically (Oktavia, 2021). With a thematic approach in webbed integrated science, students can connect various sub-themes and learning activities, strengthening their understanding of the material.

The *BRADeR* model consists of brainstorming, reading, analyzing, decision-making, and reflection and is an effective alternative for training science literacy competence. Each step in the *BRADeR* model actively engages students, encouraging them to express ideas and build prior knowledge. The reading process helps students understand and evaluate information from various sources, a core science literacy competency (Simamora et al., 2024). Analyzing the information they have read trains students to think critically and question the validity of the information (Zou'bi, 2021). By combining *webbed* integrated science learning with the *BRADeR* model, students are expected to enhance their science literacy skills significantly. This method encourages a more profound and cohesive grasp of ideas.

In this context, brainstorming is a group activity aimed at solving problems and spontaneously developing new ideas, which also serves to establish learning objectives and stimulate students' interest. The ARCS theory (Attention, Relevance, Confidence, Satisfaction) by John Keller and the Advance Organizer and Meaningful Learning theories support this approach by enhancing learning motivation and connecting new information with existing knowledge. Research indicates that brainstorming can improve students' intrinsic motivation and science literacy competencies (Komarudin et al., 2024; Christidamayani & Kristanto, 2020).

Reading is a complex activity that is essential in science literacy. Students comprehend texts and integrate new knowledge with what they already know. Regular reading activities enhance critical and creative thinking skills and facilitate the understanding of scientific phenomena and data interpretation. Research shows that a strong reading habit is closely related to science literacy, helping students understand science content and solve scientific problems based on known facts (Cao et al., 2024; Duke et al., 2021; Khan et al., 2022).

According to Bloom's taxonomy, analyzing in learning involves breaking down material into clearer components and establishing connections between ideas. It facilitates the problem-solving process and develops students' science literacy skills through investigation and experimentation. This phase is supported by various learning theories, including Assisted Learning and Discovery Learning, as well as research indicating that inquiry-based learning can effectively enhance science literacy (Fatmawati, 2024; Luzyawati et al., 2025; Ramdani et al., 2020; Schunk, 2016; Slavin, 2012).

In the current age of globalization and swift technological progress, scientific literacy is a vital ability that learners need to develop in order to comprehend scientific events and utilize their knowledge in daily life. Scientific literacy includes understanding basic concepts and the capacity to think critically, evaluate scientific data, and apply it to make informed choices. The government and the education sector strive for students to have robust scientific literacy to tackle global challenges like climate change, health concerns, and technological progress. Nevertheless, this objective has not yet been wholly achieved.

Initial research conducted at State Junior High School 1 Ngoro confirms this finding, indicating that students' scientific literacy is still lacking. This is shown by their restricted capacity to clarify scientific phenomena and utilize scientific knowledge effectively in making decisions. The disparity between what is expected and what occurs is evident in the minimal student involvement in experiment-oriented science activities, a deficiency in critical thinking abilities, and the prevalence of theoretical teaching methods that fail to provide adequate chances for practical experience. This scenario emphasizes the necessity for creative, engaging, and hands-on science education methods to close this divide and improve students' scientific understanding as expected. Research results support this problem.

The research showed that decision-making involves evaluating alternatives and choosing the option that best aligns with individual goals, considering the benefits, risks, and available information. Learning in this phase encourages students to develop hypotheses and enhance their science literacy through analysis and discussion, contributing to their logical thinking skills (Amrain et al., 2024). Reflection in learning allows students to review their learning experiences, evaluate their understanding, and communicate with teachers, supporting future learning planning (Arends, 2012). This reflective activity also develops science literacy competencies and helps students relate essential concepts (Stit et al., 2019). Environmental issues are highly relevant topics that can be applied to students' daily lives (Kumar, 2023). The Permaculture theme was chosen because it relates to the interactions between living organisms and their environment, which students still struggle to understand. This is evident from students' inadequate levels of scientific literacy, reflected in their inadequate understanding of the importance of environmental conservation and avoiding harmful substances. Previous research has shown that when students are provided with integrated learning that includes real-life examples and reflective activities, their interest in learning about the environment increases. Therefore, the topic of permaculture is very suitable for training students' science literacy competence. Based on the above discussion, an analysis of science literacy competence in *webbed* integrated science learning with a permaculture theme and the *BRADeR* model is necessary.

RESEARCH METHOD

This study employs a quantitative descriptive research approach to enhance the science literacy competence of State Junior High School 1 Ngoro students for the 2024-2025 academic year, utilizing a simple random sampling method. Researchers utilize a descriptive quantitative method to measure and detail the traits of a phenomenon without altering any variables. Simple random sampling guarantees that each person in the population has an equal chance of selection, leading to a representative and impartial sample and facilitating a more dependable generalization of the results. The research subjects consist of 80 students from class IX-A, which includes 16 students (limited trial I), and classes IX-B and IX-C, which comprise 64 students (broad trial II). These students study integrated material on environmental issues, additives, and measurements, packaged within *webbed* integrated science learning themed around permaculture and the *BRADeR* model.

Table 1. Research description.

Aspect	Details
Research Approach	Quantitative descriptive research
Objective	Enhance the science literacy competence of students
Location	State Junior High School 1 Ngoro
Academic Year	2024-2025
Sampling Method	Simple random sampling
Total Research Subjects	80 students
Class IX-A (Limited Trial I)	16 students
Classes IX-B and IX-C (Broad Trial II)	64 students

The methods of data gathering employed in this research consist of two types: tests and non-tests. The science literacy competence test developed by the author includes 10 essay questions specifically designed to measure the student's science literacy competence. These questions refer to established indicators of science literacy competence, providing a clear picture of the student's understanding and abilities in science. Additionally, non-test data collection techniques are also applied, which include observations and interviews to obtain a more profound understanding of the educational progression and the enhancement of students' science literacy competence with their science teachers. The research process is illustrated in Figure 1.

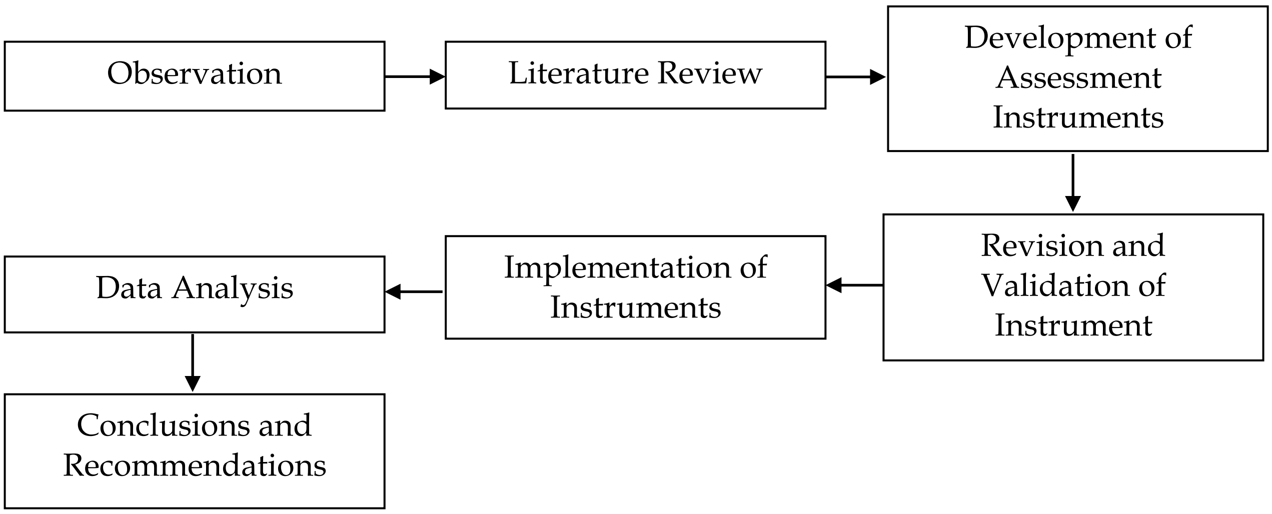


Figure 2. Research flow diagram.

Figure 2 illustrates the stages involved in the research. The study begins with identifying issues related to students' science literacy competence. Next, a literature review is conducted to gather relevant information about these issues. Following this, the researcher develops an instrument consisting of 10 essay questions that refer to three indicators of science literacy competence. Before the application of this instrument, it is validated by experts. The instrument is then tested in both limited and broad trials. The data acquired from the instrument assessment is then examined utilizing statistical methods appropriate for the research design. The final stage involves drawing conclusions and providing recommendations derived from the outcomes of the data examination. Questions for science literacy are crafted based on the specified science competencies. These inquiries seek to assess specific scientific skills. The outlined competencies form the foundation for developing science literacy inquiries (OECD, 2023) presented in Table 2.

Table 2. Description of science competencies.

No.	Science Literacy Competence	Description
1.	Explaining Phenomena Scientifically	Recognizing, generating, applying, and evaluating clarifications and resolutions for diverse natural and technological occurrences through: - Recalling and applying relevant scientific knowledge - Using different forms of representation and translating them - Making and validating accurate scientific predictions and solutions - Identifying, constructing, and evaluating scientific models - Recognizing and developing hypotheses to explain occurrences within the physical realm - Articulating the prospective utilization of scientific understanding for the community
2.	Constructing and Evaluating Designs for Scientific Investigations and Interpreting Data and Evidence Critically	Organizing, assessing, and evaluating scientific investigations, methods for answering questions scientifically, and interpreting data through: - Identifying questions within the given scientific study - Proposing appropriate experimental designs - Evaluating whether the experimental design is the most suitable for answering the question - Analyzing information conveyed through various forms, deriving precise inferences from the data, and assessing its significance
3.	Researching, Evaluating, and Utilizing scientific knowledge for informed decision-making and implementation.	Investigating and evaluating scientific data, assertions, and reasoning across diverse formats and settings, and deriving valid conclusions through: - Investigating, assessing, and conveying the comparative advantages of different sources of information (scientific, social, economic, and ethical) that may hold relevance or applicability in addressing science-related matters and evaluating whether they substantiate arguments or solutions - Differentiating assertions grounded in robust scientific evidence, specialized knowledge, and perspectives - Constructing arguments to support accurate scientific conclusions derived from a set of data - Identifying standard weaknesses in arguments related to science, such as erroneous assumptions, logical fallacies, and unsupported conclusions - Making decisions based on scientific arguments

No.	Science Literacy Competence	Description
		that aid in addressing resolutions for current challenges or long-term development

The impact of integrated science learning using the *webbed* approach with the theme of permaculture and the *BRADeR* model on science literacy competencies can be discerned from the outcomes of the pretest and posttest. This impact is measured using N-gain analysis, which indicates the difference in students' science literacy competencies before and after the intervention, using the formula:

$$G = \frac{(Spost) - (Spre)}{Smax - (Spre)}$$

Explanation :
G (gain) = Increase in science literacy competency
Spre = pretest score
Spost = Postest score
Smax = Maximum score

Following that, the N-gain calculation is performed. This modification adheres to set guidelines. These standards serve as the basis for adjusting the N-gain results by Hake (1999), as illustrated in Table 3.

Table 3. Criteria for normalized gain (N-Gain).

Score N-gain	Criteria N-gain
0.70 < N-gain	High
0.30 ≤ N-gain ≥ 0.70	Currently
N-gain < 0.30	Low

Increased science literacy competency is considered significant if the average N-gain value is medium (0.30 ≤ N-gain ≥ 0.70). Furthermore, a paired t-test is conducted between the pretest and posttest scores in the same group. The difference is significant if the p-value < 0.05 (Rosyidah et al., 2023). A homogeneity test was conducted using Levene's test to determine the appropriate analysis method to ensure the variance equality of N-gain between groups. Data is considered homogeneous in Levene's test if the p-value > 0.05. Furthermore, an independent t-test was used to compare the average N-gain between classes IX-B and IX-C. If the p-value is > 0.05, there is no significant difference between the two classes, while a p-value < 0.05 indicates a significant difference. The influence of the differences found was measured by calculating the effect size using Cohen's d. Table 4 presents the interpretation of information regarding the effect strength of applying webbed-type integrated science learning on the permaculture theme and the *BRADeR* model.

Table 4. Interpretasi effect size.

Cohen's d	Criteria
d ≥ 0.80	Large
0.50 < d < 0.80	Medium
0.20 < d < 0.50	Small

The interpretation of the data analysis results provides an overview of the effectiveness of implementing webbed-type integrated science learning with the permaculture theme and the *BRADeR* model. The intervention is declared successful in training the science literacy competence of junior high school students if there is a significant increase based on the paired t-test and a significant difference with a large effect size based on the independent t-test. The intervention needs to be evaluated and improved if no significant difference is found.

RESULTS AND DISCUSSION

Results

The science literacy competency test in the first trial was conducted in one class with 16 students. The first test was administered before the learning process (pretest), and the second test was conducted after the learning with the integrated *webbed* approach on the theme of permaculture and the *BRADeR* model (posttest). The student's mastery of science literacy is reflected in the criteria obtained from the science grading conventions, as outlined in Table 3. The outcomes of the scientific literacy evaluation from the first trial are presented in Table 5.

Table 5. Average pretest scores, posttest scores, and n-gain (Trial I).

Indicator	Question Number	Class IX-A		N-Gain	Category
		Pretest	Posttest		
Explaining Phenomena Scientifically	1, 2, 6, 10	35.00	83.50	0.75	High
Formulating and Assessing Plans for Scientific Inquiries and Analyzing Data and Evidence Critically.	3, 7, 8	38.67	86.00	0.77	High
Investigating, Assessing, and Applying Scientific Knowledge for Decision-Making and Implementation.	4, 5, 9	34.67	73.33	0.59	Currently

The results of the science literacy competency assessment from Trial I, as shown in Table 5, indicate an improvement in science literacy competencies following the learning process. The mean N-gain of the students was 0.77, which is categorized as high for the criterion of formulating and assessing plans for scientific investigations and critically analyzing data and evidence. Furthermore, an N-gain of 0.75 is categorized as high for the criterion of scientifically explaining phenomena. In contrast, an N-gain of 0.59 is classified as moderate for investigating, assessing, and utilizing scientific knowledge for decision-making and implementation. Consequently, Trial I exhibits a high N-gain in two indicators and a moderate N-gain in one indicator of scientific literacy proficiency. Based on the literacy indicators, the results of the scientific literacy competency evaluation from Trial I are shown in Figure 2.

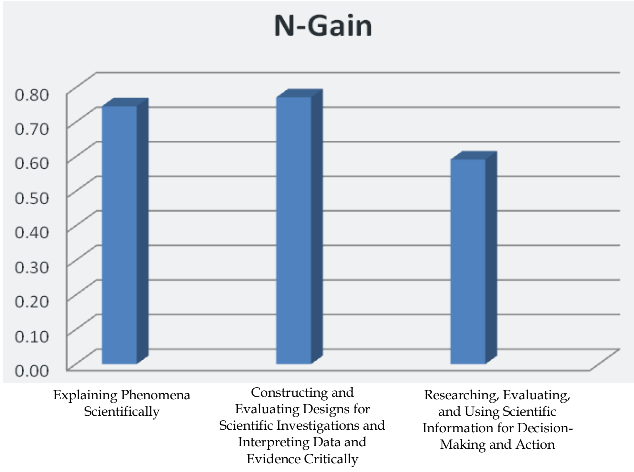


Figure 3. N-Gain indicators for science literacy competency (Trial I).

Figure 3 shows that all students in class IX-A improved from the pretest to the posttest after participating in the integrated *webbed* approach to science learning on the theme of permaculture and the *BRADeR* model, with each student's improvement varying from one another. According to these outcomes, the results can be implemented in Trial II. The science literacy competency test in Trial II was conducted in two classes, with 32 students in class IX-B and 32 in class IX-C. The science literacy competency test was administered twice: the first was conducted before the learning process (pretest), and the second was conducted after the learning with the integrated *webbed* approach on the permaculture theme and the *BRADeR* model (posttest). The student's mastery of science literacy competencies is reflected in the criteria obtained from the conversion of science literacy scores, as outlined in Table 2. The results of the science literacy competency assessment in Trial II for classes IX-B and IX-C are presented in Table 6.

Table 6. Average pretest scores, posttest scores, and n-gain (Trial II).

Indicator	Question Number	Class				Gain		N-Gain	Category
		IX-B		IX-C					
		Pretest	Posttest	Pretest	Posttest	IX-B	IX-C		
Explaining Phenomena Scientifically	1, 2, 6, 10	39.75	84.75	39.00	87.75	0.75	0.80	0.77	High
Formulating and Assessing Plans for Scientific Inquiries and Analyzing Data and Evidence Critically	3, 7, 8	37.33	84.33	37.67	86.00	0.75	0.78	0.76	High
Investigating, Assessing, and Applying Scientific Knowledge for	4, 5, 9	31.67	77.00	35.00	76.00	0.63	0.66	0.65	Currently

Indicator	Question Number	Class				Gain		N-Gain	Category
		IX-B		IX-C					
		Pretest	Posttest	Pretest	Posttest	IX-B	IX-C		
Decision-Making and Implementing Tion									

The findings of the scientific literacy evaluation from the second trial, as illustrated in Table 6, offer a comparative analysis of the mean pretest and posttest scores, along with the N-gain values for the two classes, IX-B and IX-C. According to the table, it is evident that both groups generally exhibited a rise in scores from the pretest to the posttest. The criteria for scientifically explaining phenomena, formulating and assessing plans for scientific investigations, and critically evaluating data and evidence demonstrated substantial progress in both groups. N-gain values were classified as high, scoring 0.77 and 0.76, respectively. This indicates that the implemented learning strategies successfully enhanced the students' science literacy competencies in these indicators. The indicator for investigating, assessing, and applying scientific knowledge for decision-making and implementation had an N-gain of 0.66. This indicator also showed improvement, although the N-gain was slightly lower than the previous indicators. Nevertheless, this increase remains moderate, indicating that students have progressed in critically analyzing data and evidence.

The outcomes of the science literacy evaluation from Trial II, assessed based on the student's scientific literacy competencies, encompassed three indicators: 1) describing scientific phenomena, 2) formulating, developing, and appraising frameworks for scientific investigations while rigorously examining data and evidence, and 3) investigating, assessing, and utilizing scientific knowledge for informed decision-making and implementation. Based on these literacy indicators, the results of the science literacy competency test from Trial II can be seen in Figure 4.

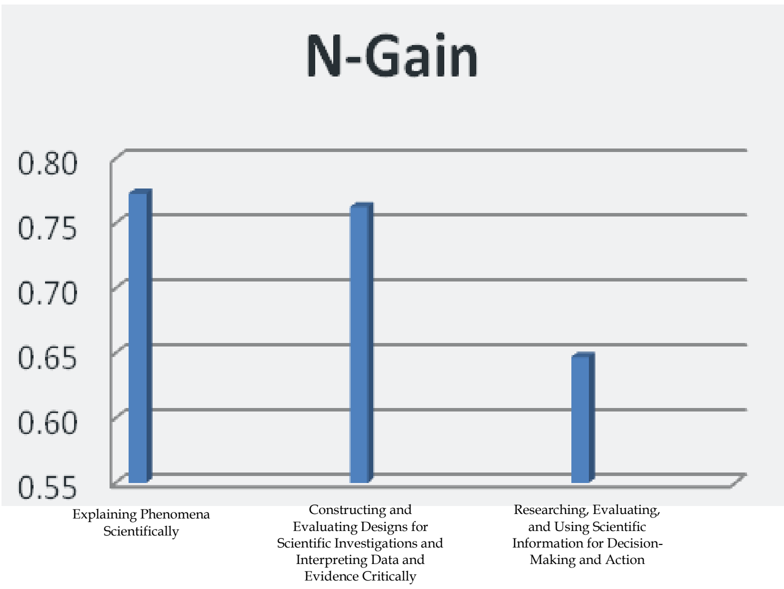


Figure 4. N-gain indicators for science literacy competency (Trial II).

The outcomes of the science literacy competency assessment from Trial II, assessed according to the science literacy indicators displayed in Figure 3, reveal that the competencies in scientifically describing phenomena, developing and analyzing frameworks for scientific inquiries, rigorously examining empirical data and supporting evidence, as well as exploring, appraising, and applying scientific knowledge for informed decision-making and implementation, have all improved and are categorized as high. The average overall pretest and posttest scores for the two sample groups are presented in Table 7.

Table 7. Average total pretest and posttest scores for 2 sample classes.

Class	Pretest	Posttest	N-Gain
IX-B	37.00	82.00	0.72
IX-C	38.00	84.00	0.74
Average	**37.50**	**83.00**	**0.73**

The average total pretest score for the two sample classes, as shown in Table 7, reached 37.50, while the average posttest score was 83, resulting in an N-gain of 0.73, which falls into the high category. This indicates that the integrated science learning using the *webbed* model with the theme of permaculture and the *BRADeR* model has effectively enhanced the students' science literacy competencies.

A paired t-test was conducted to test the significance of the science literacy competency improvement between the pretest and posttest in trial II (classes IX-B and IX-C). Previously, a normality prerequisite test was carried out to determine whether the data were normally distributed, with the hypothesis that if the significance > 0.05, the data were normally distributed, and if the significance value < 0.05, the data were not normally distributed. The normality test results are shown in Figure 4.

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Kelas9B	,120	32	,200*	,966	32	,409
kelas9C	,149	32	,070	,929	32	,036

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

Figure 4. Test of normality.

Figure 4 shows that the pretest and posttest data from trial II (classes IX-B and IX-C) are normally distributed with a significance value > 0.05 (Syahza, 2021). Further parametric statistical testing can be performed using a paired t-test if the data are normally distributed. The hypothesis for the paired t-test is that if the significance value > 0.05, there is no significant difference between the pretest and posttest in trial II, and vice versa. The paired t-test results are shown in Figure 5.

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference Lower	Upper			
Pair 1	Pre-test A - Post-test A	-47,31250	5,64222	,99741	-49,34674	-45,27826	-47,435	31	,000
Pair 2	Pre-test B - Post-test B	-44,40625	7,85292	1,38821	-47,23753	-41,57497	-31,988	31	,000

Figure 5. Result paired t-test.

Figure 5 shows that the t-test results in trial II (classes IX-B and IX-C) have a significance value of 0.00 < 0.05, meaning a significant positive difference exists between the pretest and posttest scores. This indicates that webbed-type integrated science learning with the permaculture theme and the *BRADeR* model is effective in training the science literacy competence of junior high school students. This aligns with previous research that shows that the webbed model integrated science learning can improve students' science literacy. Furthermore, a homogeneity test was conducted to ensure that the N-gain variances in trial II (classes IX-B and IX-C) were homogeneous. The hypothesis is that if Levene's test shows a p-value > 0.05, then the data are homogeneous, and vice versa. The homogeneity test results are shown in Figure 6.

Test of Homogeneity of Variances

Ngain

Levene Statistic	df1	df2	Sig.
3,893	1	62	,053

Figure 6. Homogeneity test result.

Figure 6 shows that the data analysis conducted, using Levene's Test for homogeneity, yielded a significance value of 0.05 (p > 0.05). This indicates that the variance of N-gain between the two experimental groups in trial II (classes IX-B and IX-C) is homogeneous. This homogeneity confirms that both classes had equivalent characteristics before the treatment, a condition during experimental research. This result also strengthens the study's internal validity as it shows that the class division has resulted in equivalent groups in terms of the variability of their initial abilities. This provides a strong foundation for further analysis using an independent t-test to evaluate the effectiveness of webbed-type integrated science learning with the permaculture theme and the *BRADeR* model, as the assumption of homogeneity of variance, a prerequisite for the independent t-test has been met. Furthermore, an independent t-test was conducted to confirm the homogeneity and compare the average N-gain between the two experimental classes, in this case, classes IX-B and IX-C. The hypothesis is that if the p-value > 0.05, there is no significant difference between the pretest and posttest, and vice versa. The results of the independent t-test are shown in Figure 7.

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means					95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Ngain	Equal variances assumed	3,893	,053	-1,845	62	,070	-,03813	,02066	-,07942	,00317
	Equal variances not assumed			-1,845	55,839	,070	-,03813	,02066	-,07952	,00327

Figure 7. T – independent test result.

Figure 7 shows the independent t-test analysis conducted to compare the effectiveness of webbed-type integrated science learning with the permaculture theme and the *BRADeR* model in trial II. The analysis results show a significance value (2-tailed) of 0.07 ($p > 0.05$). This indicates no significant difference in improving science literacy competence between the two classes using webbed-type integrated science learning with the permaculture theme and the *BRADeR* model. This finding indicates that implementing webbed-type integrated science learning with the permaculture theme and the *BRADeR* model has a relatively equal impact on the two classes in training their science literacy competence. This may be due to several factors, including equivalence in delivering material, consistent quality of learning implementation, or homogeneous characteristics of students in both classes. The consistent implementation of webbed-type integrated science learning with the permaculture theme and the *BRADeR* model shows a commitment to improving the quality of science education.

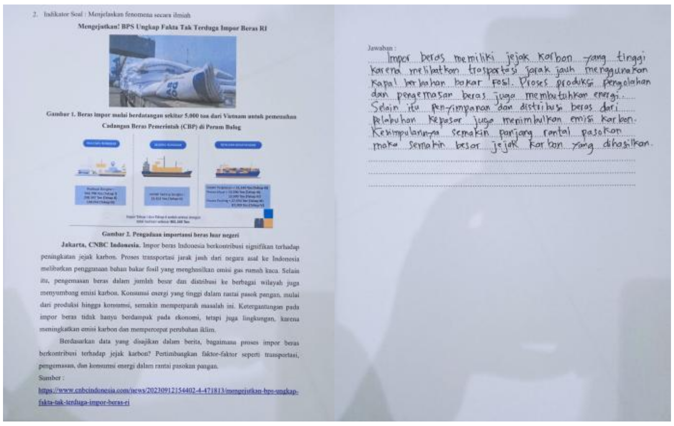
Discussion

The students' science literacy competencies were assessed using a science literacy test that included three indicators: 1) describing phenomena from a scientific perspective, 2) developing and assessing plans for scientific inquiries and critically analyzing scientific data and evidence, and 3) investigating, assessing, and applying scientific knowledge for informed decision-making and implementation. The tests were conducted twice, once before the learning process and once after. Based on the results, the average N-gain for the students was found to be 0.73, which is categorized as high. The high N-gain scores obtained can be ascribed to the fact that before the learning process, students had not mastered the material related to environmental issues, additives, and measurements, which were integrated within the permaculture theme. Although the concepts of additives and measurements were already familiar to the students from grades VII and VIII, this material had not been instructed cohesively that connected it with environmental issues.

Overall, there was an improvement in science literacy scores from the pretest to the posttest. This indicates that integrated science learning using the webbed and BRADeR models positively influenced the development of students' science literacy competencies. This study's results align with previous research that the BRADeR learning model can improve students' scientific literacy skills (Simamora et al., 2024). The BRADeR model incorporates science literacy training through five learning syntaxes: idea generation, reviewing, evaluating, problem-solving, and contemplation. During brainstorming, students are trained to solve problems or explain phenomena scientifically and develop new ideas. In the subsequent reading stage, students are expected to understand and remember information from texts and pose questions to clarify the issues they face. In the analyzing stage, students conduct investigations by gathering information through experiments and observations and collaboratively analyzing the problem-solving process. Inquiry-based learning that involves group discussions in formulating problems, preparing hypotheses, and analyzing experimental results can enhance science literacy. During the decision-making stage, learning that involves discussions and Q&A sessions can improve students' science literacy skills. The final stage, reflection, aims to assess students' success in understanding the material by observing their concentration and responses to tasks and identifying their desires and needs in detail.

The results of the science literacy competency test from the second trial, as shown in Figure 3, suggest that the capability to elucidate phenomena scientifically, devise and assess plans for scientific investigations, and rigorously analyze scientific data and evidence, as well as examine, assess, and apply scientific knowledge for informed decision-making and implementation, all experienced significant improvement, categorized as high. The indicator for explaining phenomena scientifically achieved the highest N-gain. The difficulty level in scientifically explaining phenomena can range from basic to more complex. At the basic level, students are asked to describe phenomena using simple words or concrete examples. At higher levels, students are expected to connect scientific concepts, provide explanations based on relevant scientific principles, and use appropriate scientific terminology (Luzyawati et al., 2025; Radus, 2023). These criteria necessitate advanced cognitive skills, innovation, and problem-solving competencies for developing and assessing plans for scientific inquiries, critically examining scientific data and evidence, and exploring, evaluating, and utilizing scientific knowledge for decision-making and implementation. Difficulty level may include students' proficiency in formulating pertinent research questions, designing and executing experiments or observations, gathering and interpreting data, and drawing inferences based on the evidence obtained. Below are examples of questions and answers from the science literacy competency instrument that was tested.

Indicator 1: Explaining Phenomena Scientifically


2. Indikator Soal : Menjelaskan fenomena secara ilmiah

Mengejutkan! BPS Ungkap Fakta Tak Terduga Impor Beras RI

Gambar 1. Beras impor mulai berdatangan sekitar 5.000 ton dari Vietnam untuk pemenuhan Cadangan Beras Pemerintah (CBP) di Perum Bulog

Gambar 2. Pengadaan importasi beras luar negeri

Jakarta, CNBC Indonesia. Impor beras Indonesia berkontribusi signifikan terhadap peningkatan jejak karbon. Proses transportasi jarak jauh dari negara asal ke Indonesia melibatkan penggunaan bahan bakar fosil yang menghasilkan emisi gas rumah kaca. Selain itu, pengemasan beras dalam jumlah besar dan distribusi ke berbagai wilayah juga menyumbang emisi karbon. Konsumsi energi yang tinggi dalam rantai pasok pangan, mulai dari produksi hingga konsumsi, semakin memperparah masalah ini. Ketergantungan pada impor beras tidak hanya berdampak pada ekonomi, tetapi juga lingkungan, karena meningkatkan emisi karbon dan mempercepat perubahan iklim.

Berdasarkan data yang disajikan dalam berita, bagaimana proses impor beras berkontribusi terhadap jejak karbon? Pertimbangkan faktor-faktor seperti transportasi, pengemasan, dan konsumsi energi dalam rantai pasokan pangan.

Sumber :
https://www.cnbcindonesia.com/news/20230912154402-4-471813/mengejutkan-bps-ungkap-fakta-tak-terduga-impor-beras-ri

Jawaban :
Impor beras memiliki jejak karbon yang tinggi karena melibatkan trosportasi jarak jauh mengagunakan kapal berbahan bakar fosil. Proses produksi pengolahan dan pengemasan beras juga membutuhkan energi. Selain itu penyimpanan dan distribusi beras dari pelabuhan kepasar juga menimbulkan emisi karbon. Kesimpulannya semakin panjang rantai pasokan maka semakin besar jejak karbon yang dihasilkan.

Figure 8. Questions and answers from students on the indicator of explaining phenomena scientifically.

Figure 8 illustrates an effort to assess students' competence in explaining scientific phenomena. The questions encourage students to connect scientific concepts such as the process of global warming, carbon emissions, and their environmental impacts. Wellarticulated student responses demonstrate an understanding of these phenomena and the ability to explain them using scientific language. Empirical data indicates that this evaluation approach corresponds with research emphasizing the significance of assessing students' capacity to implement scientific concepts in practical situations. Theoretically, it is based on constructivist learning theories, which suggest that students achieve a more profound comprehension of science by actively forming explanations for seen phenomena (Piaget, 1954). These viewpoints highlight the importance of assessing students' abilities in scientific explanation as a crucial component of science literacy.

Indicator 2: Constructing and Evaluating Designs for Scientific Investigations and Interpreting Data and Evidence Critically

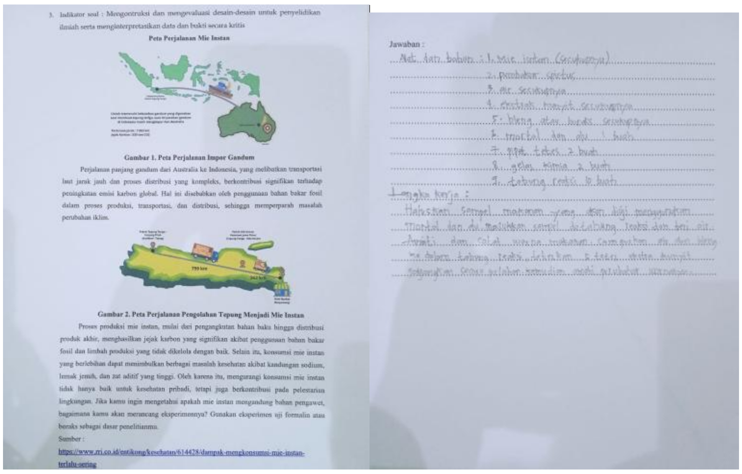
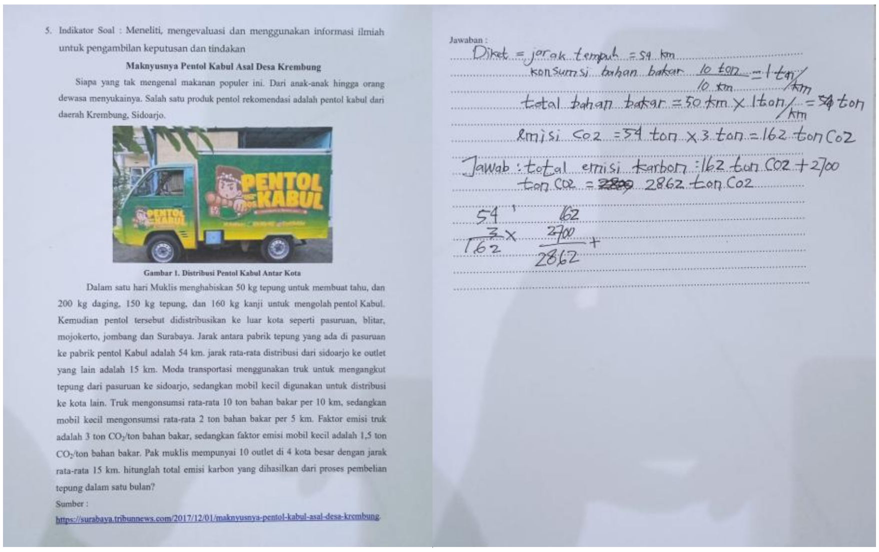


Figure 9. Students will be asked questions and answers on constructing and evaluating designs for scientific investigations and critically interpreting data and evidence.

Figure 9 illustrates an effort to assess students' competence in designing experiments, analyzing data, and drawing conclusions. The questions encourage students to comprehend scientific principles and implement them in practical contexts. Student responses exhibit analytical thinking abilities, problem-solving skills, and an understanding of the scientific process.

Indicator 3: Researching, Evaluating, and Using Scientific Information for Decision-Making and Action



5. Indikator Soal : Meneliti, mengevaluasi dan menggunakan informasi ilmiah untuk pengambilan keputusan dan tindakan

Maknyusnya Pentol Kabul Asal Desa Krembung

Siapa yang tak mengenal makanan populer ini. Dari anak-anak hingga orang dewasa menyukainya. Salah satu produk pentol rekomendasi adalah pentol kabul dari daerah Krembung, Sidoarjo.

Gambar 1. Distribusi Pentol Kabul Antar Kota

Dalam satu hari Muklis menghabiskan 50 kg tepung untuk membuat tahu, dan 200 kg daging, 150 kg tepung, dan 160 kg kanji untuk mengolah pentol Kabul. Kemudian pentol tersebut didistribusikan ke luar kota seperti pasuruan, blitar, mojokerto, jombang dan Surabaya. Jarak antara pabrik tepung yang ada di pasuruan ke pabrik pentol Kabul adalah 54 km. jarak rata-rata distribusi dari sidoarjo ke outlet yang lain adalah 15 km. Moda transportasi menggunakan truk untuk mengangkut tepung dari pasuruan ke sidoarjo, sedangkan mobil kecil digunakan untuk distribusi ke kota lain. Truk mengonsumsi rata-rata 10 ton bahan bakar per 10 km, sedangkan mobil kecil mengonsumsi rata-rata 2 ton bahan bakar per 5 km. Faktor emisi truk adalah 3 ton CO_2/ton bahan bakar, sedangkan faktor emisi mobil kecil adalah 1,5 ton CO_2/ton bahan bakar. Pak muklis mempunyai 10 outlet di 4 kota besar dengan jarak rata-rata 15 km. hitunglah total emisi karbon yang dihasilkan dari proses pembelian tepung dalam satu bulan?

Sumber :
https://surabaya.tribunnews.com/2017/12/01/maknyusnya-pentol-kabul-asal-desa-krembung.

Jawaban :

Diket = jarak tempuh = 54 km
konsumsi bahan bakar 10 ton / 10 km = 1 ton/km
total bahan bakar = 50 km x 1 ton/km = 54 ton
emisi Co2 = 54 ton x 3 ton = 162 ton Co2
Jawab : total emisi karbon : 162 ton CO2 + 2700 ton CO2 = ~~2800~~ 2862 ton Co2

54 x 3 = 162
162 + 2700 = 2862

Figure 10. Questions and answers from students on researching, evaluating, and using scientific information for decision-making and action.

Figure 10 illustrates an effort to assess students' competence in applying scientific knowledge to solve problems. The questions encourage students to comprehend scientific principles, analyze information, assess data, and make decisions grounded in solid evidence. Student responses reflect analytical thinking skills, problem-solving capabilities, and a grasp of scientific methodology. Future studies should analyze the effectiveness of integrated science learning using the webbed approach with the theme of permaculture and the *BRADeR* model across various other science topics with a broader student population.

CONCLUSION

Fundamental Finding: This research emphasizes the importance of implementing integrated science learning using the *webbed* approach with the theme of permaculture and the *BRADeR* model in training the science literacy competencies of junior high school students. The results indicate an average n-gain categorized as high, revealing that most students possess adequate science literacy competencies to achieve proficiency in understanding scientific concepts. **Implication:** The application of this learning model significantly contributes to the development of student's science literacy, which is essential for preparing them to face environmental issues. This study shows that integrating science content with a learning approach can enhance student engagement and understanding. **Limitation:** This research is limited to a single population of students at State Junior High School 1 Ngoro and focuses solely on science literacy competencies within the context of integrated science learning using the *webbed* approach with the permaculture theme and the *BRADeR* model. The results cannot be generalized to a broader population or scientific concepts. Additionally, this research design is descriptive, thus not evaluating the effectiveness of specific learning interventions. **Future Research:** Future studies should analyze the effectiveness of integrated science learning using the *webbed* approach with the theme of permaculture and the *BRADeR* model across various other science topics with a broader student population.

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