JSER

Journal of Science Education Research

Journal homepage: https://journal.uny.ac.id/index.php/jser/index

ISSN: 2597-9701

The Effect of The Culturally Responsive Teaching Approach Based on The Cembengan Tradition on Students' Science Literacy Skills in The Topic of Motion

S.I. Yulianti[1*], D. Setyawarno[2], P.W. Hastuti[3], Maryati[4], D. Rosana[5],

Natural Science Education, Faculty of Mathematics and Natural Sciences, Universitas Negeri Yogyakarta

[*]*Corresponding Author. Email: Sitiindah.2022@student.uny.ac.id Phone*: +6285643335461*

Abstract

This study examined the effect of a Culturally Responsive Teaching (CRT) approach integrated with the Cembengan Tradition on students' science literacy in motion-related material. A quasi-experimental nonequivalent control group design was employed at SMP Negeri 1 Sewon, involving two intact classes with 32 students each. Class VII B was assigned as the experimental class and received learning through the Cembengan Tradition-based CRT approach, while Class VII D served as the control class and received learning through the scientific approach. The instructional treatment integrated the Cembengan Tradition, particularly the procession activities, into motion-related learning to connect scientific concepts with students' cultural experiences and local contexts. Science literacy was assessed using pre-test and post-test instruments analyzed through the Rasch model, while data analysis included descriptive statistics, prerequisite tests, an independent samples t-test, and effect size analysis. The results indicated a significant difference in science literacy between students in the experimental and control classes. The implementation of the Cembengan Tradition-based CRT approach also showed a positive effect on students' science literacy in motion-related material. These findings demonstrate that integrating local cultural contexts through CRT can provide meaningful learning experiences by connecting scientific concepts with phenomena familiar to students. The approach supports students in interpreting and applying scientific knowledge within culturally relevant and contextual situations. Practically, science teachers are encouraged to integrate relevant local traditions into classroom learning to strengthen students' science literacy while preserving meaningful connections between science and local culture.

History

Received: April 4, 2026

Revised: August 29, 2026

Accepted: September 9, 2026

Keywords:

Culturally Responsive Teaching, Cembengan Tradition, Science Literacy

How to cite:

S.I. Yulianti, D. Setyawarno, P.W. Hastuti, Maryati, D. Rosana (2026). The Effect Of The Culturally Responsive Teaching Approach Based On The Cembengan Tradition On Students' Science Literacy Skills In The Topic Of Motion. *Journal of Science Education Research*, 7(2), 263-274. doi: https://doi.org/10.21831/jser.v10i2. 101105.

This open access article is distributed under a (CC-BY SA 4.0 License)

1. INTRODUCTION

Twenty-first-century skills have become an important focus of education, particularly in science education, as students are expected to apply knowledge, interpret information, and solve problems in various contexts (Nisrina et al., 2020). One of the essential competencies in science education is science literacy, which enables students to understand scientific concepts and use scientific knowledge to address problems encountered in everyday life (Novita et al., 2021; Chotimah et al., 2023). Therefore, assessing students' science literacy is important to determine their ability to understand and apply the scientific concepts they have learned (Pratiwi et al., 2019). However, the development of science literacy among Indonesian students remains a challenge. Based on the results of the 2022 Programme for International Student Assessment (PISA), Indonesia ranked 75th out of 80 participating countries, with an average science literacy score of 396. Although Indonesia's ranking increased by six positions compared with the 2018 assessment, its science literacy score decreased by 13 points (Saptaningrum et al., 2023; Setyawarno et al., 2023). These results indicate that Indonesian students' science literacy remains relatively low and requires further improvement.

The development of students' science literacy is closely related to the learning process and students' active engagement in learning (Setyawarno et al., 2023).. However, science learning in schools does not always provide sufficient opportunities for students to actively engage with scientific problems and relate scientific concepts to meaningful contexts. This condition was identified through observations and interviews conducted by the researcher with science teachers and students at SMP Negeri 1 Sewon over a period of three months. The findings showed that the Culturally Responsive Teaching (CRT) approach had not been optimized in science learning, while lecture-based instruction was still predominantly used. Although science learning had incorporated literacy-oriented assessment questions, students still experienced difficulties in identifying relevant information and understanding the context of problems. These difficulties affected their ability to solve problems, including calculation-based problems, as students tended to experience confusion from the initial stage of understanding the problem and were unable to present coherent and systematic solution steps. This condition indicates that students need learning experiences that provide meaningful contexts and encourage them to actively connect scientific concepts with phenomena in their surroundings..

One approach that can address these needs is Culturally Responsive Teaching (CRT), which integrates students' cultural backgrounds and experiences into the learning process. Learning that is connected to local culture can facilitate students' understanding because the learning content is related to contexts that are familiar and meaningful to them (Qusthalani, 2024). Through culturally relevant contexts, students can be encouraged to interpret information, discuss problems, and connect scientific concepts with phenomena in their surroundings. Thus, the implementation of CRT has the potential to support the development of science literacy by providing meaningful contexts for learning science. Previous research has reported that the implementation of the CRT approach can improve students' science literacy (Maskhanah et al.,2023).

Nevertheless, previous studies on CRT and science literacy have not specifically highlighted the use of the Cembengan Tradition as a cultural context for learning science, particularly in relation to motion-related topics. This creates a research gap concerning the integration of a specific local cultural practice into the CRT approach to provide meaningful contexts for students to understand and apply scientific concepts. The Cembengan Tradition is considered relevant as a learning context because its procession activities involve observable phenomena related to motion that can be connected with concepts in science learning. In addition, the tradition is conducted in the local environment surrounding the students, allowing the cultural context to be directly related to their everyday experiences. Therefore, integrating the Cembengan Tradition into CRT can provide students with a culturally relevant learning experience while creating opportunities to apply scientific knowledge to familiar phenomena.

Based on this research gap, the novelty of this study lies in integrating the Cembengan Tradition, particularly its procession activities, into the Culturally Responsive Teaching (CRT) approach for teaching motion-related topics and examining its effect on junior high school students' science literacy. This study does not merely apply CRT as a general culturally responsive approach but specifically utilizes a local cultural practice as a contextual learning resource for connecting scientific concepts with students' cultural and everyday experiences. Accordingly, this study aims to determine the effect of the Culturally Responsive Teaching (CRT) approach based on the Cembengan Tradition on junior high school students' science literacy in motion-related topics. The study also examines whether there is a difference in science literacy between students who learn through the CRT approach based on the Cembengan Tradition and those who receive conventional learning

2. LITERATURE REVIEW

2.1. Culturally Responsive Teaching Approach

The Culturally Responsive Teaching (CRT) approach is an educational approach that focuses on recognizing, respecting, and responding to the cultural diversity, backgrounds, and experiences of students in the learning process (Sari et al., 2023). Hardiana (2023) states that Culturally Responsive Teaching (CRT) involves linking students' cultural diversity as a focal point in the learning process. The objective of this approach is to create an inclusive learning environment, accommodate the unique learning needs and experiences of each student, and make students feel accepted, respected, and actively engaged in the learning process (Sari et al., 2023).

This CRT approach can be applied in the learning process to help students more easily understand the material by learning within the context of the culture around them. One of the subjects that can implement CRT is Science, which is highly accessible for both teachers and students to explore. Integrating culture into learning makes the educational experience more meaningful. Students find it easier to grasp the material because it is connected to contextual events (Rahmawati et al., 2024). Research findings (Putri et al., 2022) demonstrate that integrating culture into learning can improve learning outcomes compared to conventional teaching methods. Hernandez et al. (2013) state that the Culturally Responsive Teaching (CRT) approach encompasses five main categories:

1. Content Integration

   Content Integration is implemented by incorporating culture into learning, fostering positive relationships between teachers and students, and recognizing students' achievements.
2. Facilitating Knowledge Construction

   Teachers act as facilitators for students in constructing knowledge by incorporating what they already know into the learning process or, in other words, by constructing knowledge based on their prior experiences.
3. Prejudice Reduction

   Teachers can use a contextual approach to create a positive environment and a comfortable classroom for learning, regardless of ethnicity, culture, religion, social class, or language. This can help reduce prejudice among students, both among students themselves and between teachers and students.
4. Social Justice

   Teachers serve as agents of change who encourage students to ask questions or have the courage to express their views in order to foster political awareness and critical thinking skills.
5. Academic Development.

Teachers serve as facilitators for students in developing their academic skills. In this regard, teachers must be willing to guide and nurture students' existing competencies. The initial competencies that students possess will ultimately enable them to achieve their academic goals.

Hardiana (2023) also explains that there are several core principles of the Culturally Responsive Teaching (CRT) approach, namely:

1. Recognition of students' cultural identities
2. Building positive and inclusive relationships
3. Student-centered learning
4. Relevant and meaningful learning
5. Student empowerment.

2.2. Cembengan Tradition

Cembengan is a traditional ceremony marking the start of the sugarcane harvest and the sugarcane milling season at the Madukismo Sugar Factory. It is held annually and has been observed ever since the factory was established during the Dutch colonial period. The Cembengan traditional ceremony features a pair of "tebu manten" (wedding sugarcane) as the first sugarcane to be milled during the sugarcane milling season at the Madukismo Sugar Factory, which takes place from May to September (Nugratama et al., 2025). The series of activities in the Cembengan traditional ceremony symbolizes gratitude for the bountiful sugarcane harvest and aims to pray to God Almighty for safety, so that the sugarcane milling season proceeds smoothly and safely for sugarcane farmers, sugar mill workers, and the communities surrounding the sugar mill (Nugratama et al., 2025). The series of Cembengan Tradition events consists of the distribution of ancak-ancak, a pilgrimage to the Kotagedhe Tomb, a ceremonial feast and pilgrimage to the Mojopahit, Ba De Pok, and Rogocolo Tombs, a pilgrimage to the Imogiri Tomb, the sacrifice of the Kendhit goat and a ceremonial feast at the Spiritus Factory, a ceremonial feast and a Wayang Kulit (shadow puppet) performance at Parangkusumo Beach, the Gilingan Station Ceremony, the Procession to Harvest the Sugarcane for the Bridal Couple, the Bridal Couple's Sugarcane Procession, the Lighting of the Boiler Fire, and the start of sugarcane milling.

2.3. Scientific Literacy

Scientific literacy is defined as an individual's ability to understand and engage in issues related to science and scientific ideas as a reflective and critical-thinking citizen. Individuals who possess scientific literacy are capable of engaging in argument-based discussions about science and technology. This encompasses the competence to explain phenomena scientifically, design and evaluate scientific inquiries, and interpret data and evidence based on scientific principles (OECD, 2023). Mastering scientific literacy is essential for students so that they do not merely understand science as a concept, but can also apply it in their daily lives (Rosana et al., 2020; Sutrisna, 2021).

The emphasis of scientific literacy is not solely on the knowledge and understanding of scientific concepts and processes, but is also directed toward an individual's decision-making process and participation in societal life. Scientific literacy in this century is no longer just about using science and technology to understand the universe. Rather, scientific literacy has levels, starting from the most basic level known as practical scientific literacy, which refers to an individual's ability in daily life as a consumer of science and technology products. This relates to basic human needs, namely food, health, and housing. High-level science literacy, such as civic literacy, which refers to a person's ability to participate in decision-making and apply that knowledge wisely, is linked to political, economic, social, cultural, and national issues (Irsan, 2021). PISA states that the focus of scientific literacy assessment consists of three aspects: context, knowledge, competencies, and identity. These aspects are interconnected and form the scientific framework, commonly known as the PISA Framework (Nugratama et al., 2025). These aspects are as follows:

1. Context

PISA 2025 assesses competencies and knowledge in specific contexts that raise issues and choices that are relevant to science and environmental education. The contexts are not limited to school science contexts. Rather, the contexts are chosen based on the knowledge and understanding that 15-year-old students are likely to have acquired and considered relevant to students' interests and lives. These contexts are generally consistent with the areas of application for scientific literacy in previous PISA frameworks. The focus of assessment items is on situations relating to:

a. The self, family, and peers (personal)
b. The Community (local dan national)
c. Life across the world (global)

2. Competency

PISA views science education as serving to prepare future citizens—that is, citizens capable of participating in a society increasingly shaped by advances in science and technology. Therefore, science education must develop students' ability to understand the nature of science, scientific procedures, and the strengths and limitations of science. Students need to understand how scientists collect data and propose explanations for natural phenomena, recognize the main characteristics of scientific inquiry, and understand the types of answers that can be expected from science. This involves the ability to engage in a mental process when faced with a question or problem and to seek to solve that problem. PISA's science literacy assessment prioritizes the following areas:

a. Explain phenomena scientifically
b. Construct and evaluate design for scientific enquiry and interpret scientific data and evidence critically.
c. Research, evaluate and use scientific information fr decision making and action.

3. Scientific knowledge

The three competencies developed in science education require three forms of knowledge, namely :

a. Content Knowledge
b. Procedural Knowledge
c. Epistemic Knowledge

2.4. Scientific Study of Motion

The motion unit in junior high school is a component of science education that explores the phenomenon of object motion and its relationship to force in everyday life. The junior high school motion curriculum is outlined in the Learning Outcomes (CP) as follows: "Students are able to measure the physical aspects they encounter and apply various types of motion and force, understand the relationship between the concepts of work and energy, measure temperature resulting from applied thermal energy, and distinguish between thermal insulators and conductors."

The motion of an object is the change in its position from one point to another in space and time. Halliday et al. (2014) explain that motion is defined as the change in an object's position relative to a specific reference point over a specific time interval. This motion can be linear, circular, or oscillatory, depending on the trajectory and its cause. Serway & Jewett (2014) also state that motion is the change in an object's position over time as observed from a reference point. Motion always involves changes in position and time as the primary variables. The fundamental physical quantities are:

1. Displacement and Distance Traveled by an Object

   Halliday et al. (2014) explain that displacement is a vector quantity that indicates the change in an object's position from a starting point to an ending point, not the path it travels. Distance, on the other hand, is a scalar quantity that indicates the total length of the path traveled by an object during its motion, regardless of direction.

2. Speed and velocity

   Velocity is a vector quantity that indicates how fast an object is moving. Velocity can also refer to speed with direction. Speed, on the other hand, is a quantity that indicates how fast an object moves to cover a certain distance in a certain amount of time (Oktavia Nasution et al., 2025).

3. Acceleration

Acceleration is a vector quantity that indicates the change in an object's velocity over a given time interval. Acceleration can be positive (the object is speeding up), negative (the object is slowing down), or a change in velocity direction even though the magnitude of the velocity remains constant (Halliday et al., 2014).

Table 1. Integration Matrix of Movement Elements in the Cembengan Tradition

Science Subtopics	Science Concepts	The Cembengan Tradition Series	Analysis of Scientific Explanations
Distance	The total length of the path traveled by an object as it moves, regardless of direction.	The journey of the Tebu Manten procession to the Madukismo Sugar Factory.	The distance is indicated by the length of the route taken by the parade procession from the Madu Candya Building to the Madukismo Sugar Factory.
Movement	Change in the position of an object from the starting point to the ending point.	The Tebu Manten procession from the Madu Candya Building to the Madukismo Sugar Factory.	Tebu Manten moved from its starting point at the Madu Candya Building to its ending point in the Madukismo Sugar Factory area. The distance of the movement is determined by the starting position and the ending position..
Speed	A comparison of distance traveled and travel time, regardless of direction.	The route of the Tebu Manten procession.	If a group travels a distance of 2 km in 40 minutes, then its speed is 3 km/h. Speed only indicates the magnitude of motion without taking the direction of travel into account.
Velocity	A comparison of displacement over time that takes into account the direction of motion.	The route of the Tebu Manten procession.	If a group travels 2 km eastward in 40 minutes, then its speed is 3 km/h eastward. Speed is a vector quantity because it has a direction.
Acceleration	Change in velocity over time	Changes in the pace of the parade participants during the procession.	At the start of the procession, the participants walked slowly, then picked up speed as the group began to move steadily toward the factory. This change in speed indicates that there was an acceleration during the movement.

3. RESEARCH METHOD

The study used a quantitative approach with a quasi-experiment method and a Nonequivalent Control Group Design. The population consisted of seventh-grade students at a public junior high school, located in Yogyakarta during the second semester of the 2025/2026 academic year. The research design is described in Table 2.

Table 2. Quasi-Experimental Research Design Using a Nonequivalent Control Group Design

Group	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_2
Control	O_1	-	O_2

The sample was selected using cluster random sampling. Class VII B was assigned as the experimental class, which received the Culturally Responsive Teaching (CRT) approach based on the Cembengan Tradition. Meanwhile, class VII D was assigned as the control class, which received the scientific approach. This sampling technique was selected because it facilitates the selection of intact groups while maintaining the existing classroom structure and natural learning environment. Randomization was conducted at the class (cluster) level, giving each class an equal opportunity to be selected as either the experimental or control class

Data collection instruments consisted of tests and non-tests. Test instruments included pretest and posttest essay questions to measure science literacy abilities, while non test instruments included observation sheets on the implementation of learning and validation sheets.

Data collection was conducted in two stages: a pretest before the treatment and a posttest after the treatment in both classes. The validity of the questions was analyzed using Pearson's correlation, and reliability was tested using Cronbach's Alpha.

Data analysis techniques included descriptive statistics, normality tests (Shapiro Wilk), homogeneity tests (Levene's Test), independent sample t-tests to test differences between groups, and effect size calculations to determine the level of the treatment effect.

Table 3. Validity Test Results

No	Threshold	Level	INFIT MNSQ	OUTFIT MNSQ	Description
1.	-0,41	Moderate	0,56	-0,9	Not Fit
2.	-0,41	Moderate	1,61	1,2	Not Fit
3.	0	Very Easy	Item has perfect score		Not Fit
4.	1,00	Moderate	0,93	1,15	Fit
5.	-1,89	Easy	1,29	0,51	Fit
6.	-1,89	Easy	1,29	0,51	Fit
7.	0,41	Moderate	1,13	1,27	Fit
8.	-1,00	Easy	0,40	-1,2	Not Fit
9.	0,04	Moderate	1,78	1,45	Not Fit
10.	1,25	Difficult	0,80	0,64	Fit
11.	0,72	Difficult	0,69	0,46	Not Fit
12.	0,41	Difficult	0,88	0,92	Fit
13.	1,00	Easy	0,52	0,38	Not Fit
14.	-0,41	Moderate	1,29	1,20	Fit
15.	-1,00	Easy	0,40	0,12	Not Fit
16.	0,04	Moderate	0,97	1,21	Fit
17.	-1,89	Moderate	1,47	5,11	Not Fit
18.	0,72	Difficult	1,92	2,10	Not Fit
19.	-0,41	Moderate	0,71	0,75	Not Fit
20.	0,00	Very Easy	Item has perfect score		Not Fit
21.	2,29	Very Diffucult	1,31	1,28	Fit
22.	-0,41	Moderate	0,56	0,27	Not Fit
23.	-0,41	Moderate	0,47	0,20	Not Fit
24.	0,00	Very Easy	Item has perfect score		Not Fit
25.	2,29	Very Diffucult	1,05	0,97	Fit
1a.	-0,27	Moderate	0,97	0,99	Fit
2a.	-0,32	Moderate	0,83	0,81	Fit
3a	-0,19	Moderate	0,81	0,82	Fit
4a.	0,25	Difficult	1,32	1,60	Fit
5a	0,32	Difficult	0,91	0,85	Fit
6a	0,23	Difficult	1,17	1,23	Fit

The criteria for item fit are Infit MNSQ within 0.5–1.5, Outfit MNSQ 0.5–1.5, and Threshold between −2 and +2 (Boone et al., 2014; Dimitrov, 2012; Linacre, 2002; Meyer, 2014; Setyawarno et al., 2025). Based on the results presented in the table, the validity and item difficulty analyses of the science literacy instruments used for the pre-test and post-test indicate that, of the 25 multiple-choice items administered, 10 items (items 4, 5, 6, 7, 10, 12, 14, 16, 21, and 25) met the established criteria. Furthermore, six essay items also met the established criteria.

Table 4. Reliability Test Result

Reability Coefficient	Description
0,62	High

Based on the results presented in the table, the reliability test results for the *pre-test* and *post-test* instruments measuring students' scientific literacy skills yielded a reliability coefficient of 0.62, indicating that the instrument falls into the high reliability category. These results demonstrate that the test instrument produces relatively consistent scores when administered repeatedly to the same subjects under similar conditions.

4. RESULT AND DISCUSSION

4.1 Implementation of Instruction

The lesson implementation observation is designed to assess the appropriateness of the learning activities conducted by the observer. The lesson implementation observation sheet is completed by the observer as they observe the activities carried out by the teacher and students. If the activities carried out by the teacher and students are consistent with the statements on the learning implementation observation sheet, the observer checks the “Yes” column (√) with a score of 1. If the activities carried out by the teacher and students are not consistent with the statements on the learning implementation observation sheet, the observer checks the “No” column (√) with a score of 0.

Table 5. Learning Outcomes

Meeting	**Implementation Outcomes**		**Category**
	Eksperiment	Control	
1	100%	100%	Very Good
2	92%	92%	Very Good

Based on the observation results, it can be determined that the percentage of learning implementation in both the experimental and control classes was 100% in the first meeting and 92% in the second meeting. These percentages indicate that the learning implementation meets the very high criteria. This is in line with the opinion of Ramadhana & Hadi (2022), who state that learning implementation assessment scores ranging from 90% to 100% fall into the “very good” category.

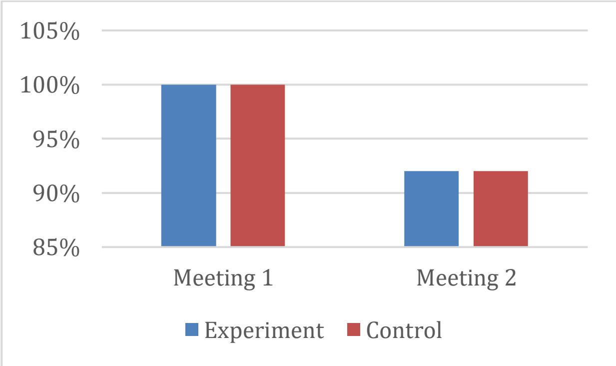

Figure 1. Graph of Feasibility Learning

4.2 Result of the Descriptive Statistical Analysis Data

The results of the descriptive statistical analysis were presented to provide an overview of students’ scientific literacy skills based on the *pre-test* and *post-test* results. The *pre-test* was administered before the learning treatment to determine the students’ initial scientific literacy skills. Meanwhile, the *post-test* was administered after the treatment to determine changes in students’ scientific literacy skills following the learning process. Descriptive statistical analysis was conducted to describe the distribution of students’ scores before and after the treatment. The results of the descriptive statistical analysis for the experimental and control classes are presented in the following table.

Table 6. Pre-test and Post-test Scores

Remarks	**Control Class**		**Experiment Class**	
	Pre-test	*Post-test*	*Pre-test*	*Post-test*
Respondent	32	32	32	32
Maximum Score	53,5	92,5	57,5	95
Minimum Score	15	40	0	47
Average	33,719	62,172	36,203	72,359

The results of the comparison between the experimental and control classes show that students in the experimental class experienced a greater improvement in scientific literacy skills than those in the control class. This finding indicates that the learning treatment applied in the experimental class contributed to better learning outcomes. The comparison of students’ scientific literacy skills between the experimental and control classes is presented in Figure 2

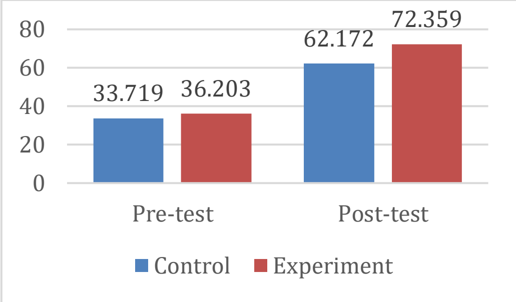

Figure 2. Graph of Average Science Literacy Scores

Based on Figure 2, a comparison of the average pre-test and post-test scores between the experimental and control classes is presented. The scores were obtained from the written test used to measure students' scientific literacy skills. The test items were systematically designed to assess the main indicators of scientific literacy, including identifying scientific phenomena, interpreting data and evidence scientifically, and drawing conclusions based on scientific evidence.

The data presented in Figure 2 show a difference in the improvement of students' scientific literacy skills between the two classes. The experimental class demonstrates a greater increase in the average score from the pre-test to the post-test compared with the control class. This finding indicates that the implementation of the Culturally Responsive Teaching (CRT) approach integrated with the Cembengan tradition provides a more optimal contribution to improving students' scientific literacy skills than the learning approach implemented in the control class.

This study used three indicators of science literacy is context, competence, and scientific knowledge, which were assessed using 10 multiple-choice questions and 6 essay questions. The author analyzed the data for each science literacy indicator by calculating the average scores of the experimental class on the pre-test and post-test answer sheets, yielding the results presented in Table 7.

Table 7. Pre-test and Post-test Scores for each Science Literacy Indicator

No	Scientific Literacy Indicator	Number of Items	Maximum Score	Experimental Class Average		Control Class Average	
				Pre-test	Post-test	Pre-test	Pre-test
1	Context	7	100	62,05	80,36	72,32	85,27
2	Competency	5	100	24,47	70,40	13,79	56,62
3	Scientific Knowledge	4	100	15,31	71,88	17,19	49,06

Based on the results of the analysis presented in Table 7, both the experimental and control classes showed an increase in scores on all indicators. However, the experimental class showed a greater increase than the control class. This indicates that the *Culturally Responsive Teaching* approach based on the Cembengan tradition is effective in improving students' science literacy skills. This is because CRT encourages students to actively engage in learning through the integration of real-world experiences into the subject matter (Mandasari et al., 2024). Rahmawati et al. (2024) also explain that integrating culture into learning makes the learning process more meaningful. Students find it easier to understand the material because it is linked to a contextual event.

4.3 Normality Test

A normality test is a method used to determine whether data come from a normally distributed population or whether they follow a normal distribution. A normal distribution is a symmetric distribution in which the mean and median are located at the center. If a distribution is described as normal, it means that the distribution has certain characteristics (Rosana & Setyawarno, 2016; Nasar et al., 2024). The data is considered to be normally distributed if the significance value is greater than 0.05. Based on the results, all pre-test and post-test data in both the experimental and control classes had significance values above 0.05. Therefore, the two classes are considered to have relatively equal initial abilities before the treatment. The significance value of the pretest is higher than the specified significance level. It means that H_0 is accepted and H_1 is rejected. Therefore, there is no significant effect of the treatment at the initial stage of learning. The results of the normality test analysis for the scientific literacy questions can be seen in Table 8.

Table 8. Normality Test Result

Kelas	Shapiro-Wilk			Remarks
	Statistic	df	Sig.	
Pre-test D (Control)	0,949	32	0,138	Normal
Post-test D (Control)	0,950	32	0,142	Normal
Pre-test B (Experiment)	0,951	32	0,158	Normal

Kelas	Shapiro-Wilk			Remarks
	Statistic	df	Sig.	
Post-test B (Experiment)	0,952	32	0,161	Normal

4.4 Homogeneity Test Result

The pretest and posttest scores were analyzed using a homogeneity test. A homogeneity test was conducted to ensure that a set of data used in a series of analyses originated from a population with homogeneous variance (Widana & Muliani, 2020). The homogeneity test in this study was performed using SPSS version 29.0. In this software, the homogeneity test was calculated using Levene's test. Data are considered homogeneous if the Levene statistic (sig) is > 0.05; conversely, data are considered non-homogeneous if (sig) is < 0.05. If the data are not normally distributed and are non-homogeneous, the analysis is performed using nonparametric tests. The results of the homogeneity test for the pre-test and post-test data on scientific literacy abilities are presented in Tabel 9.

Table 9. Homogenity Test Result

Class	Levene Statistic	df1	df2	Sig.	Description
Pre-test	0,305	1	62	0,582	Homogeneous Variance
Post-test	0,098	1	62	0,755	Homogeneous Variance

Based on the results of the homogeneity test in the table above, the *pre-test* value was 0.582 and the *post-test* value was 0.75. Both values are higher than 0.05. So, it concluded that the pre-test and post-test data between the control class and the experiment class have homogeneous variance.

4.5 Science Literacy Results

Context

The context dimension was reflected in the integration of the Cembengan tradition into the learning of motion. Through *content integration*, students encountered motion phenomena that were closely related to their cultural environment, particularly those represented in the Cembengan procession. Connecting scientific concepts with familiar cultural experiences provided students with a meaningful context for understanding motion in everyday life. Rather than being presented solely as abstract concepts, motion was discussed through phenomena that students could recognize from their surrounding environment. Such contextualization encouraged students to recognize the relevance of science beyond the classroom and interpret scientific phenomena within situations that were meaningful to them. This finding is consistent with Aprizanti (2023), who stated that science literacy can be developed through contextual problems that are closely related to students' real-life experiences.

Competency

The development of scientific competence was reflected in learning activities that required students to investigate motion phenomena, analyze information, and draw conclusions based on evidence. During the learning process, students conducted practical activities, processed measurement data, related the findings to motion concepts, and formulated conclusions based on the evidence obtained. These activities provided opportunities for students to explain phenomena scientifically and use scientific evidence to support their reasoning. This process was supported by the *knowledge construction* dimension of CRT, through which students developed their understanding through practical activities, discussions, and reflection on the cultural context. The *prejudice reduction* and *social justice* dimensions also encouraged students to exchange ideas, consider different perspectives, and evaluate arguments based on evidence. Consequently, learning involved not only the acquisition of scientific concepts but also the development of evidence-based scientific reasoning. This finding is in line with l. (2023), who reported that CRT can support science literacy by enco Setyowati et a uraging students to identify problems, analyze data, and construct arguments based on scientific evidence.

Scientif Knowledge

The development of scientific knowledge was facilitated through practical activities that connected motion concepts with the Cembengan tradition**.** Students used a toy car to represent the movement of the sugarcane procession and investigated concepts such as distance, displacement, speed, velocity, and acceleration through direct observation and measurement. This approach provided concrete experiences through which students could relate scientific concepts to observable phenomena rather than relying solely on theoretical explanations. The practical activities also involved measuring, recording, processing, and analyzing data, which supported the development of procedural knowledge alongside content knowledge. Furthermore, students used the results of their observations as evidence when formulating conclusions, providing opportunities to develop an understanding of how scientific knowledge is constructed through empirical evidence. Thus, integrating the Cembengan tradition into motion learning provided a meaningful setting for students to construct scientific knowledge through direct experience and evidence-based investigation. This finding is consistent with Safira & Agustina (2024), who reported that CRT-based learning can improve science literacy by engaging students in examining phenomena originating from their social and cultural environment.

4.6 Sigificant Differences in Science Literacy Skills Using the Culturally Responsive Teaching Approach in the Cembengan Tradition

This analysis was conducted using a parametric statistical approach with the aid of SPSS version 29 software. The selection of this technique was based on the fulfillment of the assumptions of normal distribution and homogeneity of variances, which were confirmed through prerequisite tests. Based on the results of the normality and homogeneity tests, the pre-test and post-test data from both groups showed significance values > 0.05, indicating that the data were normally distributed and homogeneous. Once the prerequisites were met, an independent samples t-test was conducted to determine the difference in conceptual understanding between the experimental and control classes (Ananda & Fadhli, 2018). The results of the independent samples t-test are shown in Table 8.

Table 10. Independent Sample T-test Result

Class	*Sig.(2-tailed)*	Criteria	Remarks
Pre-test	0,369	Sig.(2-tailed) > 0,025	H_0 accepted
Post-test	0,005	Sig.(2-tailed) < 0,025	H_0 rejected

Based on the table above, the test results show a significance value of 0.005 (*Sig. 2-tailed* < 0.025), so it can be concluded that H_0 is rejected and H_1 is accepted. This is consistent with the study by Rahmi Fitria et al. (2024), which states that in a hypothesis test using an independent sample t-test, a Sig. value of 0.000 was obtained. Since this value is less than 0.025 (0.000 < 0.025), H_0 is rejected and H_1 is accepted.

These findings are consistent with the research by Nofiana & Julianto (2018), which explains that the CRT approach tends to adapt to students' cultures and customs, making it easier for them to engage with the learning process and be prepared for assessment using science literacy evaluation instruments based on local wisdom, thereby enhancing students' science literacy in terms of content, context, and process. Nieto (2010) also states that culture-based learning can be a powerful tool for fostering students' self-confidence and appreciation of their cultural identity, which in turn can boost their motivation and interest in learning. Based on this, it can be concluded that there is a difference in science literacy abilities between students in the experimental class, which used the *Culturally Responsive Teaching* (CRT) approach based on the Cembengan tradition, and those in the control class, which used the scientific approach.

4.7 The Effect of the Culturally Responsive Teaching Approach Based on the Cembengan Tradition on Students' Science Literacy Skills

Next, to determine the extent of the treatment's effect on science literacy, an effect size analysis was conducted. The results of the analysis are presented in Table 11.

Table 11. Effect Size Test Result

Class	Scientific Literacy	
	Experiment	Control
Number	32	32
Mean	72,359	62,172
Std. Dev	13,6755	14,0303
Effect Size	0,735309	
Category	Big	

Based on the table above, the analysis results show that the implementation of the Culturally Responsive Teaching approach based on the Cembengan tradition has a high-level positive effect on students' scientific literacy skills regarding motion-related material. This is evidenced by an effect size of 0.735. This aligns with Cohen et al. (2018), who state that an effect size in the range of 0.51–1.00 meets the criteria for a strong effect. These results indicate that there is a significant effect on scientific literacy in the experimental class that used the Culturally Responsive Teaching (CRT) approach based on the Cembengan tradition compared to students who used the scientific approach.

Listyowati et al. (2023) ote that the CRT approach has a positive impact on student engagement. If student engagement increases, it will contribute to more optimal learning outcomes (Sya'bana et al., 2024). Rahmawati et al. (2024) also explain that integrating culture into instruction makes the learning experience more meaningful. Students will find it easier to understand the material because it is linked to a contextual event. Based on this, it can be concluded that using the Culturally Responsive Teaching (CRT) approach based on the Cembengan tradition has been shown to have a significant impact on science literacy compared to students who use the scientific approach. This approach also provides a more meaningful learning experience that is tailored to students' needs in the context of 21st-century learning.

5. CONCLUSION

Based on the findings and discussion, it can be concluded that the application of the Culturally Responsive Teaching (CRT) approach integrated with the Cembengan tradition has a positive effect on students' scientific literacy skills in science learning. Students who received learning through the CRT approach integrated with the Cembengan tradition demonstrated greater improvement in scientific literacy skills compared with their initial abilities and the students in the control class. This improvement is reflected in the increase in students' post-test scores after participating in the learning process.

The integration of the Cembengan tradition into science learning provides meaningful learning experiences by connecting scientific concepts with students' cultural and everyday contexts. This approach encourages students to engage actively in identifying scientific phenomena, interpreting scientific information and data, and drawing conclusions based on scientific evidence. Therefore, the implementation of CRT integrated with the Cembengan tradition not only supports students' understanding of science concepts but also contributes to the development of their scientific literacy skills. Furthermore, the effect size analysis yielded a value of 0.735309, indicating a substantial effect of the implemented approach on students' scientific literacy skills. Thus, CRT integrated with the Cembengan tradition has the potential to serve as an alternative approach for supporting the development of scientific literacy in science education.

ACKNOWLEDGMENTS

The authors would like to express their deepest appreciation and gratitude to all those who contributed to this study, especially the observers, science education faculty members, school principals, science teachers, students in classes VII B and VII D, and all others who cannot be named individually, for all the support they provided, which enabled this study to be successfully completed. In addition, we are grateful to Faculty of Mathematics and Natural Sciences Universitas Negeri Yogyakarta, for providing the grant for Research Group 2026 Number 148.68/DST/UN34.13/T/PT.01.03/2026 that enables this study to be carried out.

REFERENCES

Ananda, R., & Fadhli, M. (2018). *Statistik Pendidikan Teori Dan Praktik Dalam Pendidikan*.

Aprizanti, Y. (2023). Penerapan Model Inkuiri Terbimbing Untuk Meningkatkan Literasi Sains Siswa Dalam Pembelajaran IPA Biologi. *Jurnal Didaktika Pendidikan Dasar*, *7*(2), 411–436. [Https://Doi.Org/10.26811/Didaktika.V7i2.618.](Https://Doi.Org/10.26811/Didaktika.V7i2.618)

Boone, W. J., Staver, J. R., & Yale, M. S. (2014). *Rasch Analysis in the Human Sciences*. Springer.

Chotimah, A. N., Setyawarno, D., & Rosana, D. (2023). Effect of Guided Inquiry Model by PhET Simulations Worksheet on Science Process Skills and Mastery of Concepts. *Journal of Science Education Research*, 7(2), 100–105. https://doi.org/10.21831/jser.v7i2.63953.

Cohen, L., Manion, L., & Morrison, K. (2018). *Research Methods in Education* (Eighth Edition). New York: Routledge.

Dimitrov, D. M. (2012). *Statistical Methods for Validation of Assessment Scale Data in Counseling and Related Fields*. Wiley.

Halliday, D., Resnick, R., & Walker, J. (2014). *Fundamentals of Physics (10th ed.)* (10th ed.). Wiley.

Hardiana, D. (2023). Peningkatan Minat Belajar Ipas Melalui Culturally Responsive Teaching Pada Peserta Didik Kelas Iv Sdn 01 Sumbersari. *Didaktik : Jurnal Ilmiah PGSD FKIP Universitas Mandiri*, *9*(2).

Hernandez, C. M., Morales, A. R., & Shroyer, M. G. (2013). The development of a model of culturally responsive science and mathematics teaching. *Cultural Studies of Science Education*, *8*(4), 803–820. https://doi.org/10.1007/s11422-013-9544-1

Irsan, I. (2021). Implemensi Literasi Sains dalam Pembelajaran IPA di Sekolah Dasar. *Jurnal Basicedu*, *5*(6), 5631–5639. [https://doi.org/10.31004/basicedu.v5i6.1682.](https://doi.org/10.31004/basicedu.v5i6.1682)

Linacre, J. M. (2002). Optimizing Rating Scale Category Effectiveness. *Journal of Applied Measurement*, 3(1), 85–106.

Listyowati, S., Munjani, & Parmin. (2023). Peningkatan Emotional Activities Dan Oral Activities Siswa Melalui Pendekatan CRT Kelas 8H Di SMP Negeri 30 Semarang. *Proceeding Seminar Nasional IPA*, (32), 165–171.

Mandasari, J., Titin, & Juniardi, D. (2024). Pendekatan CRT dalam Meningkatkan Hasil dan Motivasi Belajar Peserta didik. *Jurnal Penelitian Dan Pembelajaran MIPA*, *9*(1).

Maskhanah, D. T. S. M., Lestari, A. B., & Dewi, N. R. (2023). Peningkatan Kemampuan Literasi Sains Peserta Didik Melalui Pendekatan Crt (Culturally Responsive Teaching) Dengan Alat Evaluasi Berbasis Kearifan Lokal Kesenian Gamelan Pada Materi Getaran Dan Gelombang. *Seminar Nasional Ipa Xiii*.

Meyer, J. P. (2014). *Applied Measurement with jMetrik*. Routledge.
Nasar, A., Hadi Saputra, D., Rifan Arkaan, M., Bimo Ferlyando, M., Teguh Andriansyah, M., & Dena Pangestu, P. (2024). Uji Prasyarat Analisis. *JEBI: Jurnal Ekonomi Dan Bisnis*, *2*(6), 786–799.
Nieto, S. (2010). *He Light in Their Eyes: Creating Multicultural Learning Communities*. Teachers College Press.
Nisrina, N., Jufri, A. W., & Gunawan, G. (2020). Pengembangan LKPD Berbasis Blended Learning untuk Meningkatkan Literasi Sains Peserta Didik. *Jurnal Pijar Mipa*, *15*(3), 192–199. https://doi.org/10.29303/jpm.v15i3.1880
Nofiana, M., & Julianto, T. (2018). Upaya Peningkatan Literasi Sains Siswa Melalui Pembelajaran Berbasis Keunggulan Lokal. *BIOSFER Jurnal Tadris Pendidikan Biologi*, *9*(1), 24–35. http://ejournal.radenintan.ac.id/index.php/biosfer/index
Novita, M., Rusilowati, A., Susilo, S., & Marwoto, P. (2021). Meta-Analisis Literasi Sains Siswa di Indonesia. *UPEJ*, *10*(3).
Nugratama, A. F., Alfirafindra, R., & Sulistijaningtijas, P. E. (2025). Cembengan Koreografi Yang Terinspirasi Dari Tradisi Upacara Tebu Manten. *Jurnal Seni Tari* , *24*(1), 40–57.
OECD. (2023). *PISA 2022 Results (Volume I)*. OECD. https://doi.org/10.1787/53f23881-en
Oktavia Nasution, A., Fany, A., Rio, A., Susilo, R., Nazha, D., & Lubis, A. S. (2025). Tinjauan Pemahaman Konsep Kinematika Dan Dinamika Mahasiswa Review of Students' Understanding of Kinematics and Dynamics Concepts. *Jurnal Kolaboratif Sains*, *8*(7), 4734–4742. https://doi.org/10.56338/jks.v8i7.8276
Pratiwi, S. N., Cari, C., & Aminah, N. S. (2019). Pembelajaran IPA Abad 21 dengan Literasi Sains Siswa. *Jurnal Materi Dan Pembelajaran Fisika (JMPF)* , *9*(1).
Puji Astuti, W., Priyono Budi Prasetyo, A., & Suwarsi Rahayu, E. (2012). Lembaran Ilmu Kependidikan Pengembangan Instrumen Asesmen Autentik Berbasis Literasi Sains Pada Materi Sistem Ekskresi. *Lik*, *41*(1). http://journal.unnes.ac.id/nju/index.php/LIK
Putri, D. A. H., Asrizal, & Usmeldi. (2022). Pengaruh Integrasi Etnosains Dalam Pembelajaran Sains Terhadap Hasil Belajar: Meta Analisis. *Jurnal Hasil Kajian, Inovasi, Dan Aplikasi Pendidikan Fisika*, *8*(1).
Qusthalani. (2024). PembelajaranFisikaBerdiferensiasi denganPendekatan CRT Untuk Meningkatkan Literasi Numerasi SainsSiswa. *Nusantara Journal of Multidisciplinary Science*, *2*(3).
Rahmawati, D. Z., Januar, H., Abdullah, K., & Sukamto. (2024). Pengaruh Pendekatan CRT terhadap Kemampuan Literasi Sains Peserta Didik Kelas V pada Materi Bunyi dan Sifatnya. *Journal Of Social Science Research*, *4*(4), 16756–16763.
Rahmi Fitria, Zulhendri, Z., & Kasman Ediputra. (2024). Pengaruh Pendekatan Contextual Teaching and Learning terhadap Kemampuan Pemahaman Konsep Matematis Peserta Didik Sma. *Jurnal Pendidikan Mipa*, *14*(1), 99–107. https://doi.org/10.37630/jpm.v14i1.1478
Ramadhana, R., & Hadi, A. (2022). Efektivitas Penerapan Model Pembelajaran Berbasis E-Learning Berbantuan LKPD Elektronik Terhadap Hasil Belajar Peserta Didik. *Edukatif : Jurnal Ilmu Pendidikan*, *4*(1), 380–389. https://doi.org/10.31004/edukatif.v4i1.1778
Rosana, D., & Setyawarno, D. (2016). Statistik Terapan Untuk Penelitian Pendidikan. UNY Press.
Rosana, D., Widodo, E., Setianingsih, W., & Setyawarno, D. (2020). Developing Assessment Instruments of PISA Model to Measure Students' Problem-Solving Skills and Scientific Literacy in Junior High Schools. Jurnal Pendidikan Sains Indonesia, 8(2), 292–305. https://doi.org/10.24815/jpsi.v8i2.17468.
Safira, G., & Agustina, L. (2024). Kemampuan Literasi Sains Siswa Melalui Penerapan Model Pembelajaran Problem Based Learning (PBL) Berbasis Culturally Responsive Teaching (CRT). *Bioeduscience*, *8*(3), 327–333. Https://Doi.Org/10.22236/Jbes/14619
Saptaningrum, E., Nuvitalia, D., Kurniawan, A. F., & Putri, N. E. (2023). Profil Penguasaan Literasi Sains Berdasarkan Kerangka PISA (Programme for International Student Assessment) Pada Siswa SMP Negeri Se-Kota Semarang Tahun 2022. *Jurnal Penelitian Pembelajaran Fisika*, *14*(2), 240–250. https://doi.org/10.26877/jp2f.v14i2.15482
Sari, A., Sari, Y. A., & Namira, D. (2023). Penerapan Model Pembelajaran Problem Based Learning Terintegrasi Culturally Responsive Teaching (Crt) Untuk Meningkatkan Motivasi Dan Hasil Belajar Siswa Kelas X Ipa 2 Sma Negeri 7 Mataram Pada Mata Pelajaran Kimia Tahun Ajaran 2022/2023. *Jurnal Asimilasi Pendidikan*, 1–3. http://asimilasi.journalilmiah.org.
Serway, R. A., & Jewett, J. W. (2014). *Physics for Scientists and Engineers With Modern Physics* (9th ed.). Brooks/Cole.
Setyawarno, D., Maryati, & Natadiwijaya, I. F. (2025). Promoting a valid question model for measuring computational thinking skills based on confirmatory factor analysis and Rasch model. *Cogent Education*, 12(1), 2505339. https://doi.org/10.1080/2331186X.2025.2505339.

Setyawarno, D., Rosana, D., & Kuswanto, H. (2025). 'Assessment as learning' in science instruction: A case study of Indonesian science teachers and notion for optimising in teaching and learning process. *Cogent Education*, 12(1), 2538337. https://doi.org/10.1080/2331186X.2025.2538337.

Setyawarno, D., Rosana, D., Widodo, E., & . M. (2023). Development of A Computer-Based Diagnostic Assessment to Measure Junior High School Students' Readiness to Participate AKM and PISA with Automatic Feedback. *International Journal of Membrane Science and Technology*, 10(2), 1050–1065. https://doi.org/10.15379/ijmst.v10i2.1411.

Setyowati, B. E., Indriyani, S., & Dewi, N. R. (2023). Peningkatan Keterampilan Literasi Sains Menerapkan Problem Based Learning Berbasis Culturally Responsive Teaching Pada Kelas Vii Di Smp Negeri 2 Ambarawa. *Seminar Nasional Ipa Xiii* .

Sutrisna, N. (2021). Analisis Kemampuan Literasi Sains Peserta Didik Sma Di Kota Sungai Penuh. *Jurnal Inovasi Penelitian*, *1*(12), 2683.

Sya'bana, M., Hariyono, E., & Dwi Maharani, T. (2024). Pengaruh Pendekatan Culturally Responsive Teaching Terhadap Keaktifan Dan Hasil Belajar Ipa. *Science : Jurnal Inovasi Pendidikan Matematika Dan IPA*, *4*(2).

Widana, I. W. W., & Muliani, P. L. M. (2020). *Uji Persyaratan Analisis*.