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The effect of culturally responsive transformative teaching (CRTT) model in science learning on the environmental literacy of seventh grade students

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Abstract

Background: Environmental damage in Indonesia is worsening, as shown by the low Environmental Performance Index and limited public awareness, which reflect low student environmental literacy. The Culturally Responsive Transformative Teaching (CRTT) model provides a contextual approach by integrating cultural values to enhance knowledge, attitudes, and pro-environmental behaviors.
Aims and scope of paper: This study aims to determine the effect of the Culturally Responsive Transformative Teaching (CRTT) model on science learning on the environmental literacy of 7th grade students.
Methods: This study used a quasi-experimental method with a pretest-posttest control group design. The sampling technique was selected using cluster random sampling. The research instrument was the MSELS instrument adapted from Mc.Beth and Volk (2009) in the form of multiple-choice tests and questionnaires tailored to the 7th grade science material on ecology and biodiversity. The research sample used class 7 H as the control class with a discovery learning model consisting of 32 students and class 7I as the experimental class with a CRTT model consisting of 31 students.
Result: The results showed that the CRTT model in science learning had an effect on the environmental literacy of 7th grade students with a significance value of 0.000 (0.000< 0.05).
Conclusion: The study concludes that the CRTT model effectively enhances students' environmental literacy in science learning, highlighting the need for cultural integration and further research across diverse contexts.

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INTRODUCTION

Environmental damage in Indonesia is increasingly alarming, such as flash floods in the Kendeng Pati Mountains in Central Java, severe droughts, forest fires, and mining activities that threaten the Raja Ampat ecosystem (BNPB, 2023; Majid, 2023; Nugroho, 2025; Utami, 2022). Based on the 2024 Environmental Performance Index (EPI) score, Indonesia ranks 116th out of 180

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countries with a score of 33.6 out of a maximum score of 100, indicating that the quality of the environment in Indonesia is poor (Block, et al., 2024; Siebert, 2008). According to Siebert, one of the factors contributing to Indonesia's poor EPI ranking is public indifference towards the environment (Purba & Kusumawardani, 2023). Based on micro data from the 2021 Happiness Level Measurement Survey by the Central Statistics Agency, the environmental awareness index of 65.88 (scale of 0-100) shows that public awareness of the environment is quite low (Purba & Kusumawardani, 2023). Environmental damage is caused by low environmental literacy, which is evident from the low level of knowledge, attitudes, and behaviors related to environmental awareness (Agustin & Maisyaroh, 2020). Efforts to combat environmental damage include environmental education through environmental literacy.

Environmental literacy is very important for students to prepare individuals to understand and solve environmental problems, increase their love for the environment, and preserve natural resources in Indonesia (Maulaa et al., 2020). Students who possess environmental literacy play a role in shaping an environmentally conscious character because they will have the knowledge, skills, and environmental awareness to act responsibly towards environmental issues (Rokhmah & Fauziah, 2021). It is important to instill environmental literacy from an early age, especially at school age, such as junior high school, as a way to form habits of caring for and loving the environment and internalizing an attitude of caring for the environment that will shape a strong character (Maulana & Aziz, 2022).

Several research articles have found that junior high school students in Indonesia still have low levels of environmental literacy (Fetiana et al., 2022; Safitri et al., 2020; Waqidah et al., 2020). Low environmental literacy is caused by several factors, such as environmental literacy in education being less prioritized than basic literacy (mathematics, science, technology, chemistry, biology, etc.), teachers not yet optimally emphasizing the empowerment of students' environmental literacy, and environmental content not yet being explicitly integrated into the learning process (Anggraini et al., 2019; Sarkity et al., 2023). Based on preliminary observations and interviews conducted on May 27, 2024, with one of the science teachers, it was explained that most students still lack environmental awareness. This can be seen from the students' habit of littering, their lack of participation in maintaining classroom cleanliness, and their inability to distinguish between different colors of trash bins. Teachers are still the dominant source of learning. The teaching method still uses lectures. In addition, not all environmental learning materials are integrated into every science learning process.

Environmental literacy can be instilled through contextual science learning, which develops an understanding of basic concepts related to environmental issues so that students become pro-environment (Littledyke, 2008; Santiani et al., 2024; Wilujeng et al., 2019). In science learning, students are introduced to the relationship between humans, nature, and technology, as well as their impact on the environment (Hidayat et al., 2025). However, science learning is often taught theoretically and is not closely related to the real-life environment of students. The material presented is not fully connected to the cultural, social, and environmental conditions that are close to students' lives. Students only understand environmental concepts cognitively and have not developed awareness or concern for the surrounding environment (Hidayat et al., 2025). In addition, students' varying understandings of environmental issues indicate that environmental education needs to consider and involve the different values and perspectives of students (Kang & Hong, 2021).

Several issues have been discussed, and environmental literacy needs to be improved through careful planning using an integrated learning model that incorporates environmental literacy components and values relevant to students' cultural lives (Febriasari & Supriatna, 2017; Hermawan et al., 2022). The environmental knowledge component of environmental literacy increases when students are stimulated by listening to folk tales in class at a school in the Cimahi area (Ramdhania & Djoehaeni, 2022). Students with a Ciptagelar cultural background have the knowledge and skills to

identify local rice plants from family knowledge and direct observation (Kelana, 2017). Students' personal experiences need to be integrated into environmental education because students understand more quickly and stimulate awareness of the environment (Mahaswa et al., 2024). The impact of teaching that connects students' daily lives (electricity use) increases energy conservation knowledge and improves students' environmental literacy (Craig & Allen, 2015). Effective environmental literacy learning improves problem analysis indicators through social environmental interactions and real learning contexts (Spinola, 2016).

The learning model that facilitates culturally responsive teaching and a means of improving environmental literacy is the Culturally Responsive Transformative Teaching (CRTT) model. CRTT is a learning model that integrates the culture or customs of a community in a contextual manner to instill character and cultural values that are in line with learning objectives (Rahmawati, 2020a). The CRTT model was developed from the CRT approach (Gay, 2000) and transformative learning (Taylor, 2013). The CRTT learning model has learning stages consisting of 1) self-identification, 2) cultural understanding, 3) collaboration, 4) critical reflection, and 5) transformative construction. The CRTT model is important for instilling an understanding of diversity and cultural awareness in dealing with complex issues in a multicultural society (Rahmawati, 2020a).

Research by Rahmawati et al. (2020) conducted in high schools in DKI Jakarta and West Java found that the CRTT model can develop various student competencies, one of which is environmental awareness. The increase in environmental awareness of fourth-grade students at SDN Ceger 1 Bogor with a CRT approach based on local wisdom increased significantly compared to the scientific approach (Hidayat et al., 2025). The integration of local knowledge by applying a culturally responsive approach enhances perceptual, emotional, and behavioral relationships with the environment (Magnaye, 2025). The results of Ilhami's (2019) study show that cultural understanding has not yet shown its influence on the environmental literacy of junior high school students. Several previous studies have explained that the CRTT model in science learning that examines the influence of environmental literacy on seventh-grade junior high school students has not been widely conducted. Therefore, this study is relatively new because it links the CRTT model with the environmental literacy of seventh-grade junior high school students. This study is needed to complement previous studies and provide empirical evidence of the influence of the CRTT model on environmental literacy.

Based on the background described above, this study aims to determine the effect of the CRTT model on science learning on the environmental literacy of seventh-grade students. Therefore, this study entitled “The Effect of the Culturally Responsive Transformative Teaching (CRTT) Model on Science Learning on the Environmental Literacy of Seventh Grade Students” needs to be conducted in the hope that the CRTT model can improve students' understanding of science learning and instill environmental literacy in students.

METHOD

Research Design

This study used a quasi-experimental design in the form of a pretest-posttest control group design. In a pretest-posttest control group design, both groups undergo pretesting and posttesting, with the experimental group only receiving treatment (Creswell & Creswell, 2018). This study was conducted in grade 7 at a public junior high school located in Winong Village, Winong District, Pati Regency, Central Java, at Jalan Jenderal Sudirman No.38, RT/RW 001/003,59181. The study was conducted in the even semester of the 2024/2025 academic year from March to April. This study has two research variables, namely the independent variable, which is the learning model, and the dependent variable, which is environmental literacy. The experimental class applied the CRTT model,

while the control class applied the learning model commonly used by teachers, namely the discovery learning model.

Participant

Class VII H was the control class with 32 students using the discovery learning model. Class VII I is the experimental class with 31 students using the CRTT model.

Population and the methods of sampling Instrumentatio

The population of this study was all seventh-grade students in the 2024/2025 academic year, totaling 286 students, consisting of nine classes, namely classes VII A to VII I. The research sample was selected using the cluster random sampling method, and two classes were selected. The validity and reliability of both the test and questionnaire were tested using the Rasch model. The content validity of the test and questionnaire instruments was tested by expert validators and calculated by Gregory to be 1.0, which is very high. The reliability of the test using Rasch, as seen based on Guilford's classification, was 0.83 for person reliability, 0.5 for Cronbach's alpha, and 0.91 for item reliability, which is very high. The reliability of the questionnaire had a person reliability value of 0.76 and a Cronbach's alpha value of 0.79, which is in the high category, while the item reliability value of 0.96 is in the very high category.

Instrument

The data collection techniques in this study included tests and non-tests (questionnaires). The instruments were adapted from the MSELS (Middle School Environmental Literacy Survey) developed by McBeth & Volk (2009) and adjusted to the 7th grade biodiversity material. The test consists of multiple-choice questions to measure ecological knowledge and cognitive skills. The questionnaire measures environmental affect and behavior. This questionnaire uses a five-point Likert scale (1 point = strongly disagree/never; 5 points = strongly agree/always). The validity and reliability of both the test and questionnaire were tested using the Rasch model. The content validity of the test and questionnaire instruments was tested by expert validators and calculated by Gregory to be 1.0, which is very high. The reliability of the test using Rasch, as seen based on Guilford's classification, was 0.83 for person reliability, 0.5 for Cronbach's alpha, and 0.91 for item reliability, which is very high. The reliability of the questionnaire had a person reliability value of 0.76 and a Cronbach's alpha value of 0.79, which is in the high category, while the item reliability value of 0.96 is in the very high category. Details of the environmental literacy instrument can be seen in Table 1.

Table 1. Details of the Environmental Literacy Instrument

Data collection	Component	Indicator	Item	Total Score
Test (Multiple Choice)	Ecological knowledge	Ecological Knowledge	26	60
Quetionaire (Likert Scale)	Environmental Affect	Verbal Commitment	13	30
		Environmental Sensitivity	8	25
		General Environmental Feeling	2	5
Tes (Multiple Choice)	Cognitive Skills	Issue Identifition	5	20
		Issue Analysisi	4	20
		Action Planning	1	20
Questionnaire (Likert Scale)	Behavior	Actual Commitment (pro-environemntal behavior)	13	60
Score Total Environmental Literacy				240

The determination of environmental literacy scores is based on McBeth et al., (2011), namely: the scores for the ecological knowledge component and cognitive skills component are low = 0-20, moderate = 21-40, and high = 41-60; environmental attitude and behavior component scores are low = 12-27, moderate = 28-44, and high = 45-60; and total environmental literacy scores are low = 24-96, moderate = 97-168, and high = 169-240.

Procedures

The research procedure began with identifying problems in schools. After identifying the problems, the next step was to formulate the research title and prepare a proposal. The proposal was then presented at a seminar. Next, the instruments were prepared, validated, and tested. Then, samples were taken and the learning model was applied in each class. Before learning, a pretest is conducted to measure students' initial environmental literacy. The CRTT learning model is applied in the experimental class and Discovery Learning in the control class through five face-to-face meetings on the subject of biodiversity. After learning is complete, a posttest is conducted to measure students' environmental literacy after being taught using both learning models. Next, conclusions are drawn based on the results of data analysis.

Data Analysis

The prerequisite tests for analysis consist of normality and homogeneity tests. The tests were conducted on the results of the students' pre-test and post-test on environmental literacy. The normality test used is the Kolmogorov-Smirnov test with the help of SPSS 22. The homogeneity test for this study is the Levene test with the help of SPSS 22. The Ancova (Covariance Analysis) hypothesis test is recommended because this study uses a quasi-experiment and uses humans as subjects (Susetyarini & Fauzi, 2020). In determining the hypothesis test decision, it was stated that if the significance value was >0.05, then Ho was accepted and H1 was rejected. If the significance value was <0.05, then Ho was rejected and H1 was accepted.

RESULTS AND DISCUSSION

Results

The students' environmental literacy results were obtained from the pretest and posttest scores in the control and experimental groups. In the control class, before being given treatment, the pretest score was 153.56, while the posttest score after applying discovery learning only increased to 159.41. The experimental class had an average pretest score of 153.52, which increased significantly after applying the CRTT model to 182.10. The lowest score in the control class was a pretest score of 108 and a posttest score of 137. In the experimental class, the lowest pretest score was 89 and the posttest score was 128. The highest pretest score in the control class was 193, and the posttest score was 184. The highest pretest score in the experimental class was 182, which increased to 217 in the posttest. From a comparison of the average and highest scores, both the control and experimental classes experienced an increase. However, students in the experimental class who applied the CRTT model showed better improvement in environmental literacy.

A comparison of the average pretest and posttest scores for each environmental literacy indicator in the control class and experimental class is presented in the diagrams in Figures 1. and Figure 2.

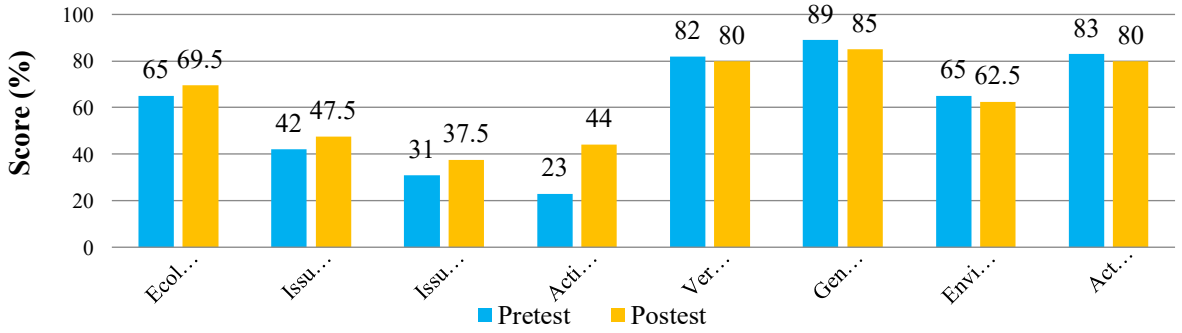


Figure 1. Diagram of Average Pretest and Posttest Scores for Environmental Literacy Indicators in Control Class (VII H)

Based on the diagram in Figure 1, in the control class that implemented discovery learning, the environmental literacy indicator that experienced the highest increase was action planning (23% in the pre-test to 44% in the post-test). The indicators of issue analysis, issue identification, and environmental knowledge also increased. However, several environmental literacy indicators experienced a decrease in scores after implementing discovery learning, but it was not significant. These indicators are environmental awareness, commitment/actual environmental behavior, environmental sensitivity, and verbal commitment.

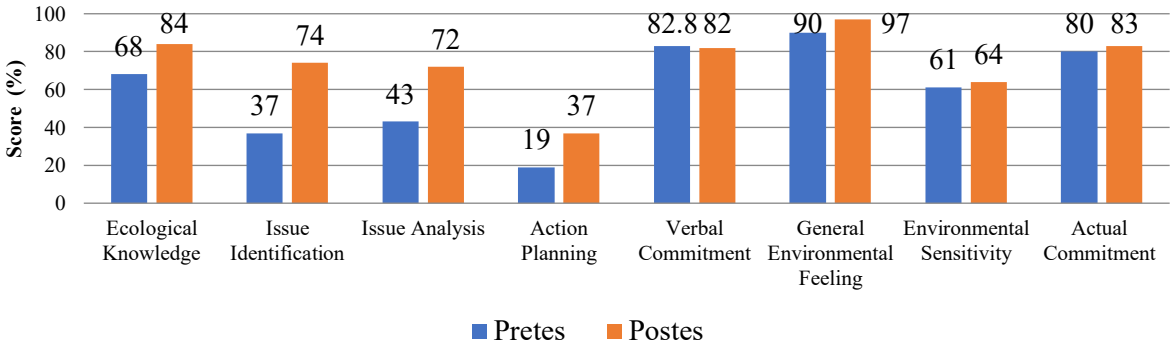


Figure 2. Percentage Diagram of Average Pretest and Posttest Scores for Each Environmental Literacy Indicator for Students in the Experimental Class (VII I)

In the CRTT class, each environmental literacy indicator showed a significant increase on average, as shown in Figure 2. However, one indicator remained unchanged, namely 82, between the pre-test and post-test. The highest increase was in the issue identification indicator, which increased by 37% (pre-test 37% and post-test 74%), followed by the issue analysis indicator, which increased by 29% (pre-test 43% and post-test 72%), the action planning indicator, which increased by 18% (pre-test 19% and post-test 37%), the environmental knowledge indicator increased by 16% (pre-test 68% and post-test 84%), the general environmental awareness indicator increased by 7% (pre-test 90% and post-test 97%), the real commitment indicator increased by 3% (pre-test 80% and post-test 83%), and the environmental sensitivity indicator increased by 3% (pre-test 61% and post-test 64%). This shows that on average, all students in the experimental class had better environmental literacy after implementing CRTT than before. The environmental literacy component scores and composite environmental literacy scores between the control class and the experimental class are presented in Table 2.

Table 2. Environmental Literacy Component and Composite Mean Scores

Component and Indicator Environmental Literacy	Maximal Score	Control Class		CRTT Class	
		Pretest	Postest	Pretest	Postest
Ecological Knowledge	60	39,0	41,7	40,7	50,2
Environmental Affect	60	45,3	43,9	44,6	45,4
Verbal Commitment Intention to Act					
Environmental Sensitivity					
General Environmental Feeling					
Cogntive Skill	60	19,4	25,8	19,9	36,6
Issue Identification					
Issue Analysisi					
Action Planing					
Environmental Behavior	60	49,9	48	48,2	49,7
Actual commitment (pro-environmenetal behavior)					
Score Total Environmental Literacy	240	153,6	159,4	153,4	181,9

The initial environmental literacy of students in the control class and experimental class was in the moderate category. In the control class, the initial environmental literacy level was in the

moderate category, as indicated by a pretest average score of 153.6. The environmental behavior and environmental attitude components were in the high category. The environmental knowledge component was in the moderate category at 39, and the cognitive skills component was in the low category at 19.4. Meanwhile, the experimental class had a total pretest score of 153.4. The environmental behavior component with a score of 48.2, the environmental attitude component with a score of 48.2, and the environmental knowledge component with a score of 40.7 were in the high category. The cognitive skills component was in the low category.

After implementing discovery learning, the students' environmental literacy level remained in the moderate category. The environmental behavior component had the highest score of 48. The greatest improvement was in the cognitive skills component (pre-test 19.4 to post-test 25.8) and environmental knowledge (pre-test 39 to post-test 41.7), while the environmental behavior and environmental attitude components experienced a decline. The environmental behavior and knowledge components were in the high category, while the environmental attitude and cognitive skills components were categorized as moderate.

In the experimental class, after applying the CRTT model, students had a high average level of environmental literacy with a post-test score of 181.9. All components of environmental literacy improved. The greatest improvement occurred in the cognitive skills component (pre-test 19.9 to post-test 36.6) and then in the environmental knowledge component (pre-test 40.7 to post-test 50.2). The environmental knowledge component had the highest posttest score of 50.2. The environmental knowledge, environmental behavior, and environmental attitude components changed to the high category, while the cognitive skills component changed to the moderate category. This shows that all students in the experimental class who applied CRTT learning experienced an increase in each component of environmental literacy compared to the control class that applied the discovery learning model.

The hypothesis test used in this study was the ANCOVA (Analysis of Covariance) test. Hypothesis testing was performed using SPSS version 22 with a significance level of 0.05. In determining the hypothesis test decision, it was stated that if the significance value was > 0.05, then H0 was accepted and H1 was rejected. If the significance value was < 0.05, then H0 was rejected and H1 was accepted. The results of the ANCOVA test of the research data are presented in Table 3.

Table 3. Results of Hypothesis Testing of Reserch Data

	Group	N	Mean	S.D.	Standard eror	*F*	*Sig*
Post-test	CRTT group	31	182,104	23,856	3,307	23,939	0,000
	Control group	32	159,399	13,281	3,255		

Table 3. shows that the hypothesis test result has a significance of 0.000, which is less than 0.05. Based on the decision-making criteria, if the sig value is <0.05, H1 is accepted and H0 is rejected. With reference to these provisions, this result shows that there is an effect of applying the CRTT model in science learning on the environmental literacy of seventh-grade students.

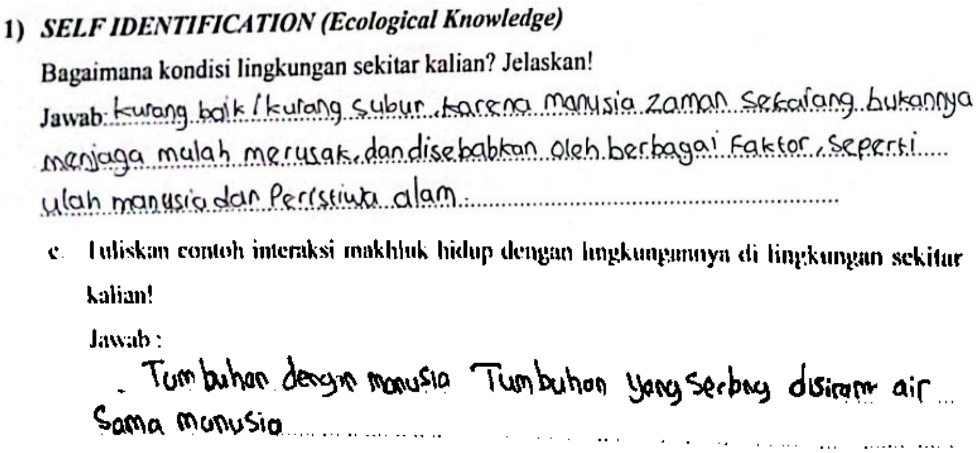
Discussion

Students' initial environmental literacy was evident from the pre-test results. Both the control and experimental classes showed moderate environmental literacy, with high scores for environmentally conscious behavior and environmental attitudes. Environmental knowledge and cognitive skills scored moderate to low. In the pre-test, students' environmental literacy was categorized as moderate because SMP N 1 Winong is an Adiwiyata school. Research by Nurwidodo et al. (2020) found that students' environmental literacy in Adiwiyata schools was generally better than in non-Adiwiyata schools. According to Coyle (2005), a moderate or adequate level of environmental literacy is defined as the ability to combine awareness and knowledge-based actions to improve the environment.

Based on the data obtained in this study, it shows that there is an influence of the discovery learning model and the CRTT model on science learning on the environmental literacy of seventh grade students. However, the CRTT model shows a better effect than discovery learning, as evidenced by the increase in the average score of all components of environmental literacy. The effect of increasing environmental literacy can be analyzed based on the stages of the learning model, including the discovery learning model in the control class and the CRTT model in the experimental class. Learning activities in the discovery learning model and CRTT model were carried out for 12 lessons, each with five meetings. In practice, some syntaxes were not implemented due to time constraints. The following is a further explanation of each component of environmental literacy in both the control class and the experimental class.

Activities in the experimental class that applied the CRTT learning model had learning stages/syntax, consisting of 1) Self-Identification; 2) Cultural Understanding; 3) Collaboration; 4) Critical Reflection; 5) Transformative Construction (Rahmawati et al., 2023). CRTT was implemented during five meetings. Session 1 discussed the topic of the influence of the environment on organisms. Session 2 discussed the topic of interactions between living things and their environment. Session 3 discussed Indonesia's biodiversity. Session 4 discussed the influence of humans on the environment. Session 5 discussed biodiversity conservation.

The first stage of the CRTT model is self-identification, in which students are guided by teachers to explore their identities (culture, customs, and background) in relation to ecology and biodiversity. Students are guided by teachers to explore their prior knowledge of ecology, such as the interactions between living things that occur in their environment. This stage of learning can improve ecological knowledge components because students use their existing knowledge, which comes from their identities, to apply it to new ecological knowledge. Students from families with cultural backgrounds and daily habits related to electricity improve their conservation knowledge (Craig & Allen, 2015; Kelana 2017). Improvements were seen in the components and indicators of ecological knowledge, with pretest and posttest scores increasing from 40.7 to 50.2, and pretest scores increasing from 60% to 84% after the application of the CRTT model. Self-identification activities can be seen in the documentation of student answers in Figure 3.


1) ***SELF IDENTIFICATION (Ecological Knowledge)***

Bagaimana kondisi lingkungan sekitar kalian? Jelaskan!

Jawab: kurang baik / kurang subur, karena manusia zaman sekarang bukannya menjaga malah merusak, dan disebabkan oleh berbagai faktor, seperti ulah manusia dan perristiwa alam.

c. Tuliskan contoh interaksi makhluk hidup dengan lingkungannya di lingkungan sekitar kalian!

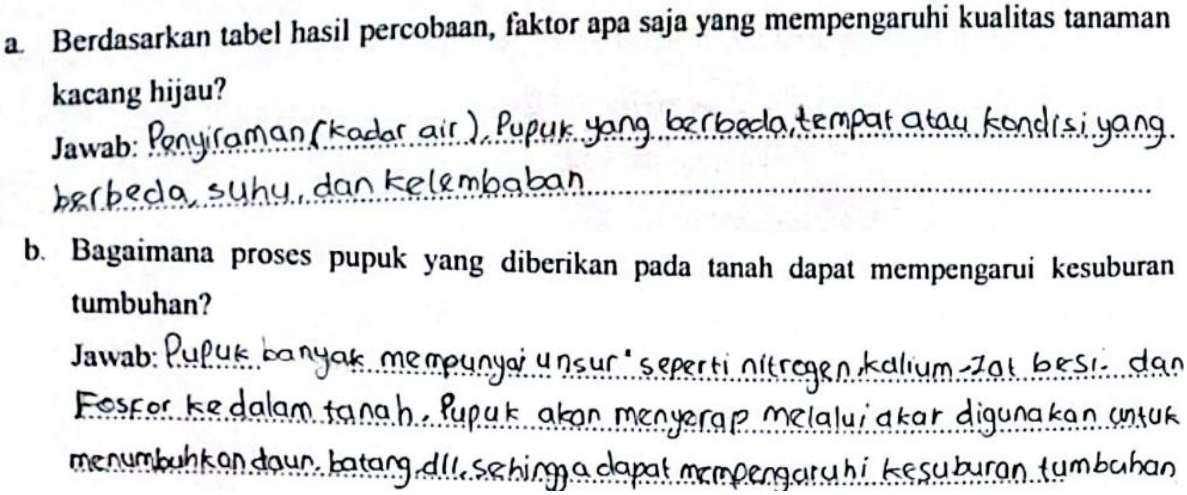
Jawab :

- Tumbuhan dengan manusia Tumbuhan yang sering disiram air sama manusia

Figure 3. Documentation of answers Student self-identification activities

The second stage is cultural understanding. At this stage, students understand their culture through stimulation from videos, direct observation, reading ethnoscience texts, and responding to environmental issues around students presented by teachers. Activities in this syntax can increase the components of ecological knowledge and environmental affect, which include indicators of verbal commitment, feelings towards the environment, and environmental sensitivity. The findings of this study are in line with those of Mashami (2025), who found that integrating green chemistry and local wisdom helps activate cognitive and affective dimensions by fostering empathy and environmental

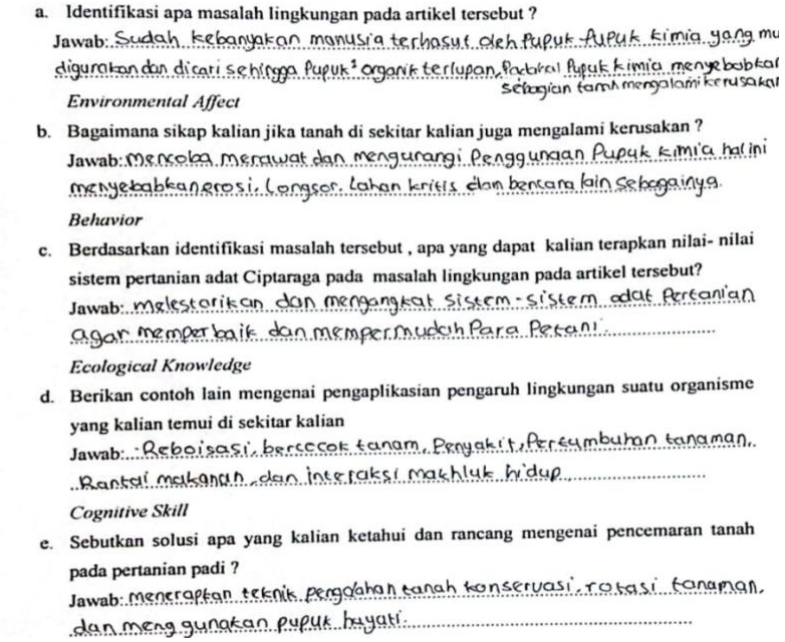
responsibility. Integrating local knowledge into the science curriculum gives students the opportunity to protect themselves from environmental exploitation and guides them to engage with and critically address sociocultural issues (Handayani et al., 2018). The increase in ecological knowledge and environmental affect is shown in Figure 2 and Table 2, which show the difference between students' pretest and posttest scores. Ecological knowledge experienced the second highest increase, and environmental affect had an average pretest score of 44.6 and a posttest score of 45.4, with verbal commitment indicators remaining the same (pretest 82.8% and posttest 82%), feelings toward the environment increasing by 7% (90% to 97%), and environmental sensitivity increasing from 61% to 64%. This is thought to be because the CRTT model integrates many real-world issues that are familiar to students.


a. Berdasarkan tabel hasil percobaan, faktor apa saja yang mempengaruhi kualitas tanaman kacang hijau?
Jawab: Penyiraman (kadar air), Pupuk yang berbeda, tempat atau kondisi yang berbeda, suhu, dan kelembaban

b. Bagaimana proses pupuk yang diberikan pada tanah dapat mempengarui kesuburan tumbuhan?
Jawab: Pupuk banyak mempunyai unsur seperti nitrogen, kalium, zat besi, dan Fosfor ke dalam tanah. Pupuk akan menyerap melalui akar digunakan untuk menumbuhkan daun, batang, dll, sehingga dapat mempengaruhi kesuburan tumbuhan

Figure 4. Students' Cultural Understanding Activities through Local Environmental Context Exploration

In the fourth stage, critical reflection, it is hoped that this syntax can improve ecological knowledge, environmental awareness, cognitive skills, and behavior. In practice, this has not been optimally achieved due to time constraints. The ecological knowledge component was achieved when, in meetings 3 and 4, students presented the results of their LKPD work to the class in different ways to convey the knowledge they had acquired. These different presentations can improve environmentally conscious behavior, such as students creating rhymes and singing as a form of facilitation so that their diverse thoughts can be conveyed through behavior that demonstrates concern for the environment to other students. The cognitive and environmental affect components are achieved when students express their opinions through debates and discussions between groups. Environmental learning requires appropriate methods such as debates to encourage students to learn to understand real-life issues (Hayati, 2020). Students respond to each other's work on the problems in the worksheets. Although it was carried out, the debate was ineffective due to time constraints. The process of reflecting on students' experiences by presenting environmental issues will engage students emotionally in learning, which will improve their attitudes toward the environment and influence their actions toward the environment (Hayati, 2020). Furthermore, the topics presented in the LKPD encourage students to discuss and debate, solve various environmental issues, and take action to restore the environment and form pro-environmental habits (Suryawati et al., 2020). The critical reflection stage is a process of transforming competencies by presenting complex environmental problems in accordance with the students' backgrounds and experiences so that they become emotionally involved in learning (Rahmawati, 2018).



a. Identifikasi apa masalah lingkungan pada artikel tersebut ?
Jawab: Sudah kebanyakan manusia terhasut oleh pupuk-pupuk kimia yang mu digunakan dan dicari sehingga pupuk² organik terlupan, Padahal pupuk kimia menyebabkan sebagian tanah mengalami kerusakan
Environmental Affect

b. Bagaimana sikap kalian jika tanah di sekitar kalian juga mengalami kerusakan ?
Jawab: Mencoba merawat dan mengurangi Penggunaan Pupuk kimia hari ini menyebabkan erosi, Longsor, lahan kritis dan bencana lain sebagainya.
Behavior

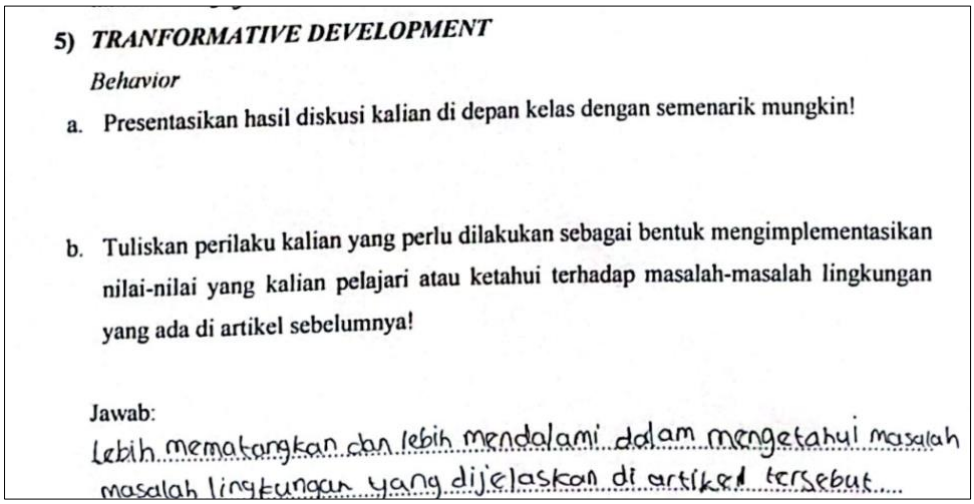
c. Berdasarkan identifikasi masalah tersebut , apa yang dapat kalian terapkan nilai- nilai sistem pertanian adat Ciptaraga pada masalah lingkungan pada artikel tersebut?
Jawab: melestarikan dan mengangkat sistem-sistem adat Pertanian agar memperbaik dan mempermudah Para Petani.
Ecological Knowledge

d. Berikan contoh lain mengenai pengaplikasian pengaruh lingkungan suatu organisme yang kalian temui di sekitar kalian
Jawab: Reboisasi, bercocok tanam, Penyakit, Pertumbuhan tanaman, Rantai makanan, dan interaksi makhluk hidup
Cognitive Skill

e. Sebutkan solusi apa yang kalian ketahui dan rancang mengenai pencemaran tanah pada pertanian padi ?
Jawab: menerapkan teknik pengolahan tanah konservasi, rotasi tanaman, dan menggunakan pupuk hayati.

Figure 5. Students' Critical Reflection Process on Environmental Issues during CRTT Implementation

The final stage of CRTT learning is transformative construction. It is hoped that this syntax will improve ecological knowledge and behavior. The implementation of this syntax has not been optimal due to time constraints. This syntax was only implemented in meetings 1 and 3. Students were encouraged to take key points from the material studied to determine their understanding at the end of each meeting. Students reflected verbally on changes in environmentally conscious behavior as a form of applying the understanding they had learned. This stage can increase environmental knowledge and pro-environmental behavior because students use the knowledge they have learned during one meeting to reflect on their understanding and behavioral changes experienced after applying CRTT. The results of the study (Rahmawati, 2020b) show that students' values have changed, becoming more aware and responsible for their culture while feeling more capable of mastering chemistry concepts. When students think critically about the environment, environmental values are instilled in them, which will guide them to think and act based on high environmental awareness (Nasution, 2021). Students who use their understanding and experience critically will have a positive influence on their ability to make decisions and act in an environmentally friendly manner (Hayati, 2020).



5) ***TRANFORMATIVE DEVELOPMENT***

Behavior

a. Presentasikan hasil diskusi kalian di depan kelas dengan semenarik mungkin!

b. Tuliskan perilaku kalian yang perlu dilakukan sebagai bentuk mengimplementasikan nilai-nilai yang kalian pelajari atau ketahui terhadap masalah-masalah lingkungan yang ada di artikel sebelumnya!

Jawab:
Lebih mematangkan dan lebih mendalami dalam mengetahui masalah masalah lingkungan yang dijelaskan di artikel tersebut.

Figure 6. Transformative Construction Activities Showing Students' Pro-Environmental Awareness Development

The environmental literacy level of CRTT class students increased significantly from moderate to high with an average score (pre-test 153.52 to post-test 182.10) compared to control class students who applied discovery learning and still had a moderate level of environmental literacy. Students in the experimental class had an average high environmental literacy category with the components of ecological knowledge, environmental impact, and environmentally conscious behavior (behavior) in the high category, while the cognitive skills component was in the moderate category. Rahmawati's (2020a) research shows that the use of the CRTT learning model has been proven to develop students' soft skills, including environmental awareness. Learning with a culturally responsive approach applied in the summer is effective in developing students' awareness of the environment and their responsibilities as citizens in their community (Stevenson & Casler-Failing, 2023).

All environmental literacy components improved after the CRTT model was implemented in the classroom. The highest improvement was found in the component with the highest posttest score, namely cognitive skills. Figures 1 and Figure 2 show that most environmental literacy indicators improved, except for verbal commitment, which decreased by 0.8. This was due to students' confidence in expressing their opinions. During the pretest, many students answered hesitantly, but after the posttest, some students wrote on the question sheet that they did not have air conditioning at home. This affected the verbal commitment indicator score. The CRTT model develops students' character, especially argumentation, empathy, communication, and confidence through article debates in chemistry learning (Rahmawati et al., 2017).

The comparison of improvements between the control class and the experimental class on several environmental literacy indicators shows that all students in the experimental class that implemented CRTT learning experienced greater improvements on each environmental literacy indicator compared to the control class that implemented the discovery learning model. The CRTT learning model has been proven effective in improving critical thinking skills, scientific attitudes, and soft skills, including environmental awareness. Through CRTT, students learn to recognize the cultural heritage of various ethnic groups, build meaningful relationships between students, and create a culturally relevant learning environment (Adawiyah et al., 2022; Lusida et al., 2024; Rahmawati, 2020a; Whatoni et al., 2024).

In this study, the control class applied discovery learning using general environmental issues, while the experimental class applied CRTT by integrating culture or daily experiences into the learning material. The CRTT model enables students to learn contextually by connecting themselves with their daily lives or cultural customs and accommodating the cultural diversity around them (Markey et al., 2021; Rahmawati, 2020). CRTT learning can influence environmental literacy because culturally responsive and transformative learning enables students to develop the skills and knowledge to become critical thinkers who are able to make and apply reflective decisions in personal and social actions (Kim & Slapac, 2015). Furthermore, environmental literacy learning occurs through effective social and environmental interactions, which require real-world learning contexts (Spinola, 2016).

The discovery learning model is more suitable for teaching cognitive and comprehension aspects than other aspects, and this learning model is difficult to control for students with varying characteristics in large classes (Khasinah, 2021; Prilliza et al., 2020). This can be seen in Figure 1, where the highest increase was in the action planning indicator, followed by issue analysis, and then issue identification, which are included in the cognitive skills component and the environmental knowledge (ecological knowledge) component. In this study, syntactic stimulation, problem statements, data collection, and data processing tended to significantly improve students' cognitive skills and ecological knowledge. This is because students are often stimulated by general problems through student worksheets that use news texts, occasional direct observations, and images (illegal

mining, poaching, soil pollution). Then, students analyze these problems by asking questions, designing hypotheses, and proving them by searching for various sources of information. Meanwhile, syntactic verification and syntactic generalization were only carried out in meetings 1 and 2; the other meetings were not carried out due to time constraints.

In the control class, several other indicators, such as feelings toward the environment, actual commitment to environmental behavior, environmental sensitivity, and verbal commitment, experienced a slight decline. During classroom learning, learning often takes place inside the classroom, causing students to become easily bored and less directly involved with the outside environment. This has an impact on students' environmental literacy. Environmental literacy tends to be higher and more effective when it requires a real-world learning context, where direct contact with nature increases and interaction with the environment and its problems is encouraged (Spinola, 2016). Integrating outdoor activities into science learning can help students develop emotional connections with nature and pro-environmental behaviors (Otto & Pensini, 2017). Furthermore, discovery learning in the learning process focuses only on the process of understanding, with less attention given to the development of emotional attitudes and cognitive skills in students (DeDonno, 2016).

Implications

The findings of this study imply that integrating the Culturally Responsive Transformative Teaching model into science instruction can serve as an effective pedagogical strategy for strengthening students' environmental literacy in junior high schools. By connecting scientific concepts with students' cultural backgrounds and daily experiences, learning becomes more meaningful and contextually grounded. This approach encourages students not only to understand environmental issues cognitively but also to develop emotional engagement and responsible environmental behaviors. The significant improvement in cognitive skills and ecological knowledge suggests that CRTT supports higher order thinking and problem solving in environmental contexts. Furthermore, the model promotes inclusive learning by valuing cultural diversity as a learning resource rather than a barrier. For educators, these findings highlight the importance of designing science learning that is culturally situated and transformative in nature. At the institutional level, CRTT can be considered as a framework to strengthen environmental education programs, especially in schools that aim to foster sustainable character development. Overall, the implementation of CRTT has the potential to contribute to long term environmental awareness and responsible citizenship among students.

Limitations

Despite the positive findings, this study has several limitations that should be carefully considered when interpreting the results. One major limitation is the limited instructional time, which constrained the optimal implementation of all CRTT learning stages. Some phases, particularly critical reflection and transformative construction, could not be carried out in depth due to scheduling constraints. In addition, the study was conducted in an Adiwiyata school, where students already possessed moderate environmental literacy, which may have influenced the magnitude of the observed improvement. The sample size was also limited to two classes from a single school, reducing the generalizability of the findings. Another limitation lies in the reliance on self reported questionnaire data to assess affective and behavioral components, which may be influenced by social desirability bias. The study did not include long term follow up to examine whether changes in environmental behavior were sustained over time. Furthermore, classroom based learning dominated the implementation, with limited outdoor or field based activities. These limitations indicate that the results should be interpreted cautiously and contextualized within the scope of the study.

Suggestions

Future research is recommended to extend the application of the CRTT model across diverse school contexts, including non Adiwiyata schools and schools in different cultural settings. Researchers should allocate sufficient instructional time to ensure that all CRTT stages can be implemented thoroughly and reflectively. Incorporating more outdoor and experiential learning activities may further strengthen students' emotional connections with environmental issues. Longitudinal studies are also needed to examine the sustainability of changes in students' environmental literacy and pro environmental behavior. In addition, future studies could integrate qualitative methods such as interviews or classroom observations to capture deeper insights into students' learning experiences. Teachers are encouraged to receive professional development on culturally responsive and transformative pedagogy to enhance instructional effectiveness. Collaboration between schools and local communities may also enrich learning by providing authentic environmental contexts. Through these efforts, future research and practice can further optimize the role of CRTT in environmental education.

CONCLUSION

This study demonstrates that the Culturally Responsive Transformative Teaching (CRTT) model has a statistically significant and pedagogically meaningful effect on improving the environmental literacy of seventh-grade students in science learning. The integration of students' cultural backgrounds, lived experiences, and local environmental contexts within the CRTT framework enables deeper conceptual understanding and more reflective engagement with ecological issues. Compared with discovery learning, CRTT more effectively enhances not only environmental knowledge but also cognitive skills related to issue identification, analysis, and action planning. The findings indicate that contextual and culturally grounded instruction supports the development of holistic environmental literacy, encompassing knowledge, attitudes, skills, and pro-environmental behaviors. This evidence reinforces the importance of aligning science pedagogy with students' sociocultural realities to foster meaningful and lasting learning outcomes. Despite these strengths, the implementation of CRTT was constrained by limited instructional time, which affected the optimal execution of several transformative learning stages. Nevertheless, the overall improvement observed suggests that CRTT remains robust even under practical classroom limitations. Therefore, CRTT can be considered a viable and effective pedagogical approach for strengthening environmental literacy in junior high school science education, with strong potential for broader application and further investigation across diverse educational contexts

AUTHOR CONTRIBUTIONS STATEMENT

SRAW: conceptualized the study, designed the research framework, coordinated the implementation of the learning intervention, and led the writing of the original manuscript.
RMP: contributed to the development of the research instruments, supervised the data collection process, and provided critical input on the alignment between the learning model and environmental literacy constructs.
IKW: was responsible for data analysis, interpretation of statistical results, and the preparation of tables and figures presented in the results section.
MNH: contributed to the theoretical foundation of the study, particularly in integrating culturally responsive and transformative learning perspectives, and reviewed the manuscript for conceptual coherence.
KDHG: supported the implementation of the learning activities in the classroom, assisted in data validation, and contributed to the discussion of pedagogical implications.

NYI: contributed to the literature review, ensured the relevance and accuracy of cited studies, and refined the discussion section to strengthen scholarly arguments.
LM: provided overall academic supervision, critically reviewed the final manuscript, and ensured that the study met ethical standards and publication requirements.

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