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DEVELOPMENT OF ETHNO-CRT LEARNING MODEL TO IMPROVE CRITICAL THINKING SKILLS AND SCIENCE LITERACY IN ECOLOGY AND BIODIVERSITY MATERIALS

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Keywords

Ethno-CRT, critical thinking, science literacy, ethnoscience, ecology.

Abstract

This research aims to develop an Ethno-CRT (Culturally Responsive Teaching) learning model based on Ethnoscience to improve students' critical thinking skills and science literacy on ecology and biodiversity materials. This research is a development research using a 4-D model (Define, Design, Develop, and Disseminate). The products developed include Ethno-CRT learning model books, syllabus, lesson plans, science e-modules, as well as critical thinking and science literacy test instruments. The results of validity by experts and readability by students show that the entire Ethno-CRT mitigation model is in the "valid" category and is very worthy of testing. The trial was carried out in two classes, namely class VIIA as an experimental class using the Ethno-CRT model and class VIIB as a control class with the CRTT model. The results of data analysis showed an increase in critical thinking skills and higher science literacy in the experimental class. The n-gain value of critical thinking ability in the experimental class reached 0.71 (high category), while the control class was 0.50 (medium category). For science literacy, the experimental class obtained an n-gain of 0.64 and a control class of 0.40, both in the medium category. So, the Ethno-CRT learning model in science learning ecology and biodiversity materials is very feasible and effective to be used to improve the critical thinking skills and science literacy of junior high school students.

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INTRODUCTION

In recent years, attention to 21st century skills development in education has increased. The 21st century is marked by the rapid development of science and technology in various fields of life, so that education is faced with increasingly great challenges. The (Febriani et al., 2022) National Education Association identifies 21st century skills as "*The 4Cs*" skills which include critical thinking, creativity, communication, and collaboration. (Azmi Zakiyah & Sudarmin, 2022; Thornhill-Miller et al., 2023) Critical thinking is the thinking ability that students need in facing learning in the 21st century. In addition, science literacy is also an important skill that must be developed in science learning in the 21st century. (Meryastiti & Rashid Ridlo, 2022; Pieter et al., 2025). In addition, scientific literacy is also an important skill that must be developed in science learning in the 21st century (Cahyani et al., 2024; Hartatiek et al., 2021; Mukti et al., 2022; Romlah et al., 2025).

The 2022 PISA results stated that Indonesia's science literacy score has decreased by 13 points from the 2018 PISA results. In PISA 2022, Indonesia obtained an average score of 383, 102 points adrift of the global average score. The acquisition of this score means that Indonesian students have a relatively low science literacy ability. A person's literacy ability can be influenced by the critical thinking skills they have (Azrai et al., 2020; Cahyani et al., 2024; Romlah et al., 2025). There is research that states that scientific literacy skills in science learning in secondary schools are still low (Azzura Salsabilla & Liliana, 2022; Syahrum Sujudi et al., 2020; Tillah & Subekti, 2025). Not only low science literacy skills, research conducted on junior high school students in science lessons also shows that critical thinking skills are also in the medium to low category (Meryastiti et al., 2022; Rahmadana Hidayati et al., 2021; Safitri et al., 2022). The low critical thinking and science literacy skills of students are caused by learning methods and models by teachers, learning facilities, learning resources, teaching materials and learning environments (Vioni Amalia et al., 2024)

The results of observations at SMPN 1 Kuok show that teachers tend to still use questions that are conceptual and memorized, which has not led to the development of critical thinking skills and science literacy. The questions given generally only test the understanding of the material theoretically, not on scientific application or reasoning. In addition, when students were asked about the relationship between science subject matter and local wisdom in their environment, most showed confusion. The findings show the importance of learning innovations that are able to encourage the development of critical thinking skills and science literacy in students.

Ethnoscience learning can improve students' critical thinking skills and science literacy. (Azmi Zakiyah & Sudarmin, 2022; Fionita & Wulandari, 2024; Verawati et al., 2023)(Kotimah et al., 2024; Sudarmin et al., 2020; Yohanista Nona Bogar et al., 2024). Ethnoscience as an activity to transform/reconstruct community knowledge that has been going on and down into scientific knowledge. The knowledge of the people that can be observed includes customs, customs, behaviors, art, religion, language, myths and symbols (Ilhami et al., 2020; Sudarmin et al., 2022). The ethnoscience approach is an approach that integrates scientific knowledge with cultural knowledge, traditions, and local wisdom. Ethnoscience-based learning in its application requires a learning model.

Teachers play a very important role in developing and implementing ethnoscience-based learning. Things that teachers must pay attention to include learning approaches, learning models, student characteristics, the environment as a learning resource to the traditional culture of the community (Sumarni, 2018). The learning model used must have learning steps that are in accordance with ethnoscience-based learning (Falah et al., 2018; Siami et al., 2023). One of the learning methods that links learning to the culture of students is the Culturally Responsive Transformative Teaching (CRTT) model developed by Rahmawati & Ridwan (2017).(Fadila et al., 2022; Rahmawati et al., 2020)

Learning that is integrated with culture will associate learning in the classroom with students' daily lives and also encourage students to take an active role in the learning process (Azmi Zakiyah & Sudarmin, 2022; Rahmawati & Ridwan, 2017). Ethnoscience provides students with the opportunity to understand science through the perspective of the culture they are familiar with, so that it can enhance their understanding and involvement in the learning process (Fitriya et al., 2025). By paying attention to local cultural and knowledge aspects, learning can be more relevant and meaningful for students (Handayani et al., 2022; Kristanto et al., 2024). The problem is, the implementation of science learning at SMPN 1 Kuok shows that learning based on local wisdom and cultural traditions is still rarely applied. The problem was known based on the results of interviews with teachers and several students in grade VIII of SMPN 1 Kuok.

As a solution, this study aims to develop an Ethno-CRT learning model that can improve students' critical thinking skills and science literacy. This research develops a learning model as an innovative product of research that will contribute to the development of science and education in the 21st century. This model is conceptually designed by integrating elements of local culture into learning, so that students not only understand scientific concepts, but are also able to relate them to local wisdom that exists in their environment.(Hasanah et al., 2025)

Local wisdom of the prohibition with the tradition of *mencokou* is one of the learning resources that can be used in science learning. The *mencokou* tradition is one of the cultural practices that contains high ethnoscience values. *Mencokau* is a joint fishing activity that is carried out in lubuk larangan, which is a customarily protected water area and can only be used in a certain period (Ferlania, 2020; Yunus, 2020). This tradition reflects the principles of natural resource conservation that are in line with the concepts of ecology, biodiversity, energy cycle, and environmental sustainability in science learning. Ecology and biodiversity materials are very relevant topics to be associated with local culture and wisdom in the larang deep. This Ethno-CRT learning model is expected to provide contextual learning, as well as form better critical thinking skills and science literacy.

METHODS

This research is an R&D (research and development) research with a 4D (define, design, develop, and disseminate) model initiated by Thiagarajan et al (1974). The 4D method in this development research aims to determine the feasibility and effectiveness of improving critical thinking and science literacy of junior high school students through the development of Ethno-CRT learning model products on ecology and biodiversity materials. The development of the Ethno-CRT learning model using the 4D model can be seen in Figure 1.

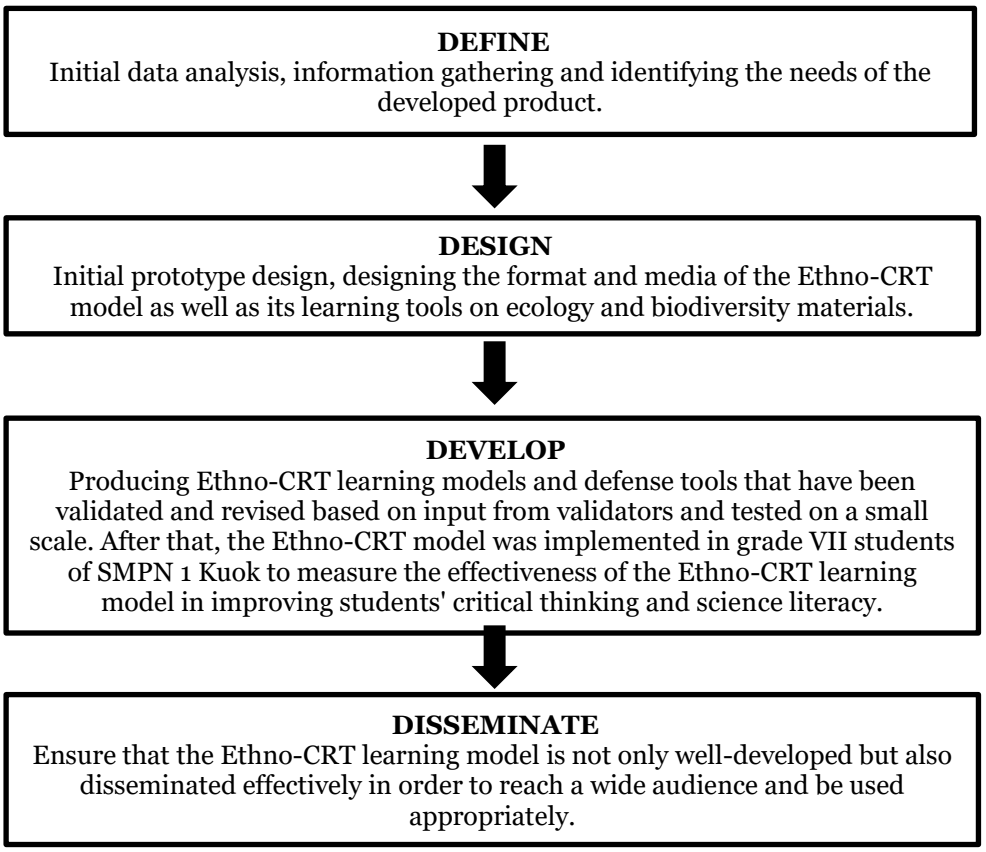

Figure 1. Development and Research Flow of Ethno-CRT Learning Model Using 4D Model

The implementation of the Ethno-CRT learning model was given to a class of experimental group of grade VII students at SMPN 1 Kuok, Kampar Regency, Riau Province. The implementation stage of this research uses the Quasi Experiment method with Nonequivalent Control Group Design. In the design of this study, students in the control and experimental classes were given a pretest to find out the initial state of the students. After the pretest, each class was given a different learning treatment. Posttests were conducted at the end of the meeting in each control and experimental class.

The data collection techniques in this study are non-test and test. Data collection techniques in the form of non-tests were used to measure the feasibility and practicality of the Ethno-CRT learning model. Data collection techniques in the form of tests were used to determine the effectiveness of the Ethno-CRT learning model in improving students' critical thinking skills and science literacy. The data collected in this development research includes the results of product expert validation, product readability tests, and product effectiveness

in improving critical thinking skills, and improving science literacy.

The feasibility assessment data of the Ethno-CRT learning model and the developed learning tools were analyzed using the Aiken's V formula (Kotimah et al., 2024). Aiken (1985) explained the formula for calculating the validity coefficient of Aiken V.

$$V = \frac{\sum s}{[n(c-1)]} \text{with } s = r - Lo$$

V velue is compared to V_{table} based on the number of validators and the choice of scale used with a probability of 5%. The data is said to be valid if the value of the V velue ≥ V_{tabel} (Aiken, 1985). Based on the Aiken V, V_{tabel} was obtained with the number of validators as many as 5 validators and 4 scale options and used with a probability of 5% which is 0.87. The results of the readability questionnaire by students are analyzed with the following formula.

$$P = \frac{f}{N} \text{ x } 100\%$$

The results of students' pretest and posttest data were analyzed using normalized gain (N-gain) calculation to determine the effectiveness of the Ethno-CRT learning model in improving students' critical thinking skills and science literacy. The improvement of students' critical thinking skills and science literacy was measured by calculating the N-gain score using a formula obtained from Hake (1999)

$$\langle g \rangle = \frac{(Sf)-(Si)}{100\%-(Si)}$$

The criteria for the N-gain factor can be seen in Table 1.

Table 1. N-Gain Factor Interval Criteria (Hake, 1999)

Interval	Criterion
$0.00 < \langle g \rangle \leq 0.3$	Low
$0.3 < \langle g \rangle \leq 0.7$	Medium
$0.7 < \langle g \rangle \leq 1.00$	High

The category of interpretation of effectiveness in the percentage of the average score of N-gain according to Hake can be seen in Table 2.

Table 2. N-Gain Factor Interval Criteria (Hake, 1999)

Percentage (%)	Criterion
>76	Highly effective
56-75	Effective
40-55	Less effective
<40	Ineffective

RESULTS AND DISCUSSION

Eligibility of the Ethno-CRT Learning Model

The feasibility data of the Ethno-CRT learning model was obtained from the results of validation by expert validators consisting of 3 lecturers of FMIPA (Faculty of Mathematics and Natural Sciences) UNNES (Semarang State University) and 2 science teachers of SMPN 1 Kuok as well as the results of readability by students on a small scale, namely 15 students VII of SMPN 1 Kuok. The validation aims to analyze the feasibility results of the Ethno-CRT learning model. The results of expert validation are presented in Table 3.

Table 3. Product Validation Results by Experts

Yes	Aspects	Stuttgart	Table	Category
1.	Type	0.93	0,87	Valid
2.	Syllabus	0.93	0,87	Valid
3.	RPP	0.91	0,87	Valid
4.	E-module	0.93	0,87	Valid
5.	Assessment	0.91	0,87	Valid

The assessment of the development of the Ethno-CRT learning model includes various aspects consisting of the Ethno-CRT model guidebook, syllabus, lesson plans, science e-modules, and instruments for critical thinking and science literacy. Based on Table 3, it shows the results of the analysis of each aspect of validation by experts. It can be seen in the table that $V_{velue} \geq V_{table}$ so that 5 aspects are declared valid. However, the validation results were also accompanied by suggestions for improvement from experts for the improvement of the Ethno-CRT learning model. The researcher then revised it according to the input, resulting in a learning model that is suitable for use in small-scale trials.

The Ethno-CRT learning model that has been revised according to the advice of expert validators is then tested on a small scale, namely a media readability test. The sample of this small-scale trial was 15 students VII SMPN 1 Kuok. The readability test was carried out with the aim of determining the readability of the Ethno-CRT learning model. At the small-scale trial stage, a readability test by students is very necessary, because it is the students who use the learning model directly (Kotimah et al., 2024). In this test, it is also hoped that students can provide suggestions and criticisms related to the media before the media is tested on a large scale. The results of the readability analysis of the Ethno-CRT learning model are presented in Table 4.

Table 4. Readability Data by Students

Yes	Valuation	Average (%)	Score	Category
1.	Aspects of Learning Activities (Ethno-CRT Model)	0,99	99 %	Highly feasible
2.	Material Aspects	0,97	94 %	Highly Worth It
3.	Media Aspects	0,95	95%	Highly Worth It

The readability data of the Ethno-CRT learning model in Table 4 shows that every aspect of learning activities, material aspects and media aspects of the Ethno-CRT learning model has very feasible criteria. This shows that the Ethno-CRT learning model can be used as a reference in understanding ecology and biodiversity materials well. The readability of the material in the e-module will affect students' comprehension (Azmi Zakiyah & Sudarmin, 2022). This readability data is then taken into consideration for further research on a large scale to apply the Ethno-CRT learning model with the aim of improving the critical thinking skills and science literacy of junior high school students.

The Effectiveness of the Ethno-CRT Learning Model in Improving Critical Thinking Skills

In addition to validating and testing the Ethno-CRT learning model products, the question instruments were also validated to measure students' critical thinking skills and science literacy. Reasoned multiple-choice questions and valid and reliable essay questions were used to measure the level of students' critical thinking ability and science literacy in order to determine the effectiveness of the Ethno-CRT learning model (Kotimah et al., 2024). Students' critical thinking skills were measured using an evaluation test in the form of a reasoned multiple choice which refers to a critical thinking indicator consisting of 10 questions.

The field trial used two classes, namely class VII A as an experimental class using the Ethno-CRT learning model with e-module media that has been developed, and class VIIB as a control class. In both research classes, the same material is taught, namely ecology and biodiversity. The results of the pretest and post-test tests in the experimental class and the control class were used to see the results of the gain in students' critical thinking skills. The results of the n-gain score test for students' critical thinking skills based on the answers to the evaluation questions given are presented in Table 5.

Table 5. Results of the Student N Gain Test on Critical Thinking Ability

Class	Average		N-Gain	Category
	Pretest	Posttest		
Experiment	41.51	82.69	0.71	High
Control	40.86	70.43	0.50	Medium

Table 2 shows the results of the pretest and posttest in the experimental class showing a significant increase, from an average of 41.51 in the pretest to 82.69 in the posttest. The n-gain value of 0.71 is in the high category, which indicates that the use of the Ethno-CRT learning model is able to optimally improve critical thinking skills. Meanwhile, in the control class, despite the increase from 40.86 to 70.43, the n-gain value of 0.50 was only included in the moderate category.

The low score of the students' pretest is due to the fact that they are not used to working on critical thinking problems, besides that students do not have enough initial knowledge so that there are still conceptual errors in the material (Kotimah et al., 2024). The low pretest score shows that before being given treatment, most students have not mastered the critical thinking skills needed to understand and solve problems in ecology and biodiversity materials. After the implementation of the Ethno-CRT learning model in the experimental

class, there was a significant increase in posttest scores. In contrast, in the control class, despite the improvement, this result was not as optimal as the experimental class. This shows that learning with the CRTT model also has an impact on improving critical thinking (Diana et al., 2024), but not as optimal as the Ethno-CRT approach. The average percentage value of each critical thinking indicator increased significantly after applying the Ethno-CRT learning model. The results of the analysis of the increase in critical thinking indicators are shown in Figure 2

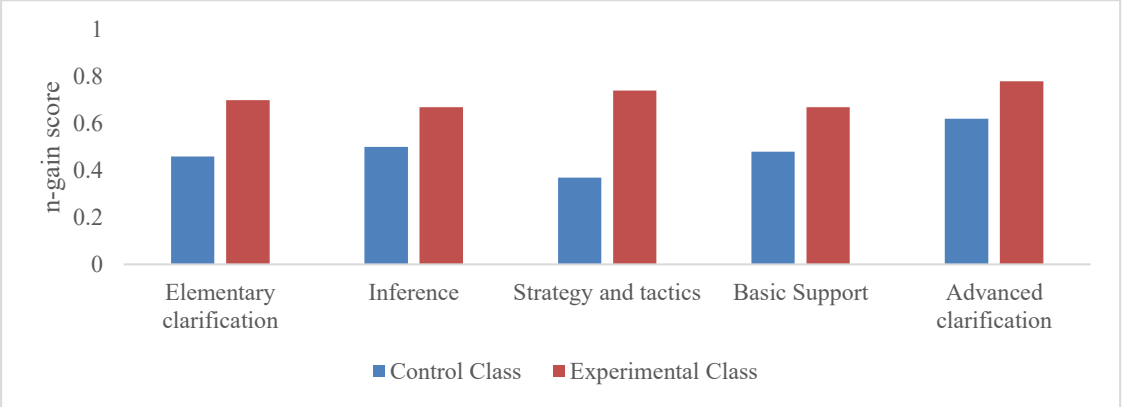

Figure 2. Indicators of Critical Thinking Ability

Figure 2 shows the N-gain per indicator of students' critical thinking ability. The data showed that there was an increase in concept comprehension scores in each indicator of student concept comprehension in the experimental and control classes. The increase in concept comprehension score in the experimental class was higher than in the control class. This is because there is a different treatment between the two. Critical thinking skills are developed through activities and materials contained in the Ethno-CRT learning model. The results of this study are in line with research by Hidayati & Julianto (2025), which shows that ethnoscience approaches can improve students' thinking skills.(Hidayati & Julianto, 2025)

The Effectiveness of the Ethno-CRT Learning Model in Improving Science Literacy

Science literacy is defined as scientific knowledge and skills to be able to identify questions, acquire new knowledge, explain scientific phenomena, and draw conclusions based on facts, understand the characteristics of science, awareness of how science and technology shape the natural, intellectual, and cultural environment, and the willingness to engage and care about science-related issues (OECD, 2016). The science literacy skill indicators used in this question use references from the OECD (2016). The science literacy skills measured in this study include identifying scientific issues, explaining scientific phenomena based on scientific knowledge, and using scientific evidence to draw the conclusions described

Students' science literacy is measured using an evaluation test in the form of essay questions which refers to science literacy indicators consisting of 10 questions. The results of the effectiveness of the Ethno-CRT learning model on students' science literacy in ecology and biodiversity materials were obtained from the analysis of the results of the pretest and postest science literacy on each indicator that has been filled in by the students. The effectiveness of the Ethno-CRT learning model on science literacy was tested in class VII A as an experimental class and class VII B as a control class. The results of the n-gain score test for students' science literacy are presented in Table 6.

Table 6. Results of the N Gain Test of Students in Science Literacy

Class	Average		N-Gain	Category
	Pretest	Posttest		
Experiment	41.11	77.60	0.64	Medium
Control	39.59	63.13	0.40	Medium

Table 3 presents the results of the science literacy pretest and posttest in the experimental and control classes. From the above data, the experimental class obtained an n-gain score of 0.64 in the medium category. And the control class obtained an n-gain value of 0.40 in the medium category. The difference in n-gain values between the two classes showed that even though they were in the same category, students in the experimental class experienced a significantly higher increase in science literacy. This reinforces the evidence that Ethno-CRT learning is not only effective in practicing critical thinking, but also in developing students' ability to understand, apply, and evaluate scientific information relevant to daily life. This is in line with the research of Hidayati & Julianto (2025), which states that by integrating elements of local culture into science learning, students will learn to analyze, evaluate and create new knowledge based on their own experiences (Hidayati & Julianto , 2025). This is also supported by research by Fitriya *et al*., (2025) which states that science learning with ethnoscience-based science modules is effective in improving science literacy in terms of attitudes in grade VII

students. (Fitriya et al., 2025). The results of the analysis of the improvement of science literacy indicators are shown in Figure 3.

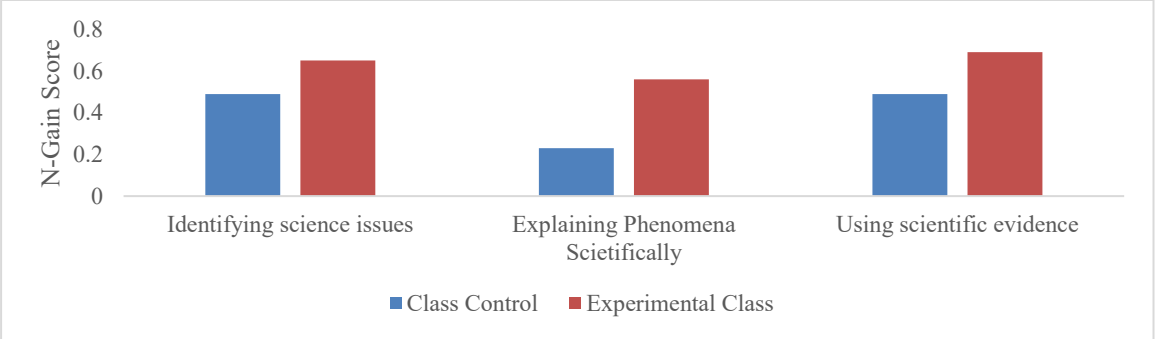

Figure 3. Science Literacy Indicators

Figure 3 shows that the average percentage value of each science literacy indicator increased after the implementation of the Ethno-CRT learning model. The increase in science literacy scores in the experimental class was higher than in the control class. This is because there is a different treatment between the two. This difference in N-Gain values indicates that although CRTT has contributed to creating inclusive and contextual learning (Handayani et al., 2022; Inayah et al., 2023), the Ethno-CRT model that adds direct and specific exploration of ethnoscience in a local context has been found to have a greater influence in developing students' science literacy. This model motivated by local culture and wisdom allows students to learn science not only as a theory, but also as part of their daily cultural and ecological experiences (Sumarni, 2018).

CONCLUSION

Based on the results of the research and development of the Ethno-CRT learning model on ecology and biodiversity materials for grade VII junior high school students, it can be concluded that the quality of the Ethno-CRT learning model on ecology and biodiversity materials for grade VII junior high school students that was developed obtained very good eligibility criteria on the results of validation tests from experts and readability tests from students, so that it is suitable for use in the science learning process. The Ethno-CRT learning model has also been proven to be effective in improving students' critical thinking skills and science literacy, which is proven through the analysis of n-gain values from pretest and posttest results. In critical thinking skills, the experimental class obtained an n-gain of 0.71 in the high category, while in the aspect of science literacy, the experimental class obtained an n-gain of 0.64 (medium category). So, the Ethno-CRT learning model in science learning ecology and biodiversity materials is very feasible and effective to be used to improve the critical thinking skills and science literacy of junior high school students.

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