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ASSESSING ENVIRONMENTAL KNOWLEDGE OF HIGH SCHOOL STUDENTS ON MANGROVE'S ROLE IN CLIMATE CHANGE MITIGATION: A CASE STUDY IN THE MAHAKAM DELTA

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Abstract

Mangrove ecosystems play an important role in climate change mitigation through their ability to absorb and store carbon. Students' knowledge about this needs to be improved to support students' environmental awareness. This study aims to measure the level of environmental knowledge of grade XI students in the Mahakam Delta region about the role of mangroves in mitigating climate change. The research method used a quantitative descriptive method, with data collection through written tests. The results showed that the average environmental knowledge of students was 61.62 with a sufficient category. The results of the frequency distribution of students show 38% of students have environmental knowledge in the good category, 36% are in the sufficient category, 11% are in the less category, and 15% are in the very less category. Although most students have environmental knowledge in the good category, there are no students who reach the excellent category, and 71% are still below the good category. Therefore, efforts are needed to improve students' environmental knowledge, especially through integration into science/chemistry learning.

Keywords: Mangrove Ecosystem, Environmental Knowledge, Climate Change, Chemistry Education

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INTRODUCTION

Climate change is a global phenomenon that has a wide impact on life, so it requires serious attention from the education sector to increase students' environmental awareness (Filho et al., 2023). In the learning outcomes of science subjects in phase E (Kemendikbudristek, 2024), the issue of climate change is integrated through the competency of analyzing the impact of human activities on the environment and finding science-based solutions. However, its implementation requires a contextual approach, especially in areas with high ecological vulnerability, such as the Mahakam Delta region of East Kalimantan province, which faces serious threats due to mangrove deforestation.

Mangrove forests in the Mahakam Delta area of East Kalimantan province covering 113,553.44 hectares (Priyono et al., 2022)The delta discharges into the Makassar Strait, whose width varies between 200 and 300 km, with a length of about 600 km(Van et al., 2020). Plays a crucial role in mitigating climate change because of its ability to absorb four times more carbon dioxide than ordinary tropical forests (Choudhary et al., 2024). In addition to ecological functions, mangroves also provide economic benefits to coastal communities through the fisheries sector (Rasyidi et al., 2024). However, exploitation by the aquaculture and energy industries has reduced the mangrove area by 85% (Darlan *et al*., 2016; Sodikin, 2021), exacerbating the impacts of climate change.

Low community knowledge about the role of mangroves in climate change mitigation is a major factor in mangrove deforestation (Rahmadi *et al*., 2020). The Mahakam Delta region, a barn of shrimp ponds and oil and gas producers, has been severely degraded by land conversion (Aslan et al., 2021). This threatens biodiversity and accelerates carbon emissions, so locally-based education in schools in these areas, such as in Anggana and Muara Badak sub-districts, is necessary. Integrating environmental issues into learning is essential so that students are able to understand environmental issues more deeply, develop critical thinking, and act to protect nature. (Suarlin, 2023).

Science learning has strategic potential to integrate environmental issues on mangrove deforestation contextually into learning materials (Manus *et al*., 2024). This is very relevant to the science learning outcomes in phase E, namely: students have the ability to understand climate change so that they are responsive and can play an active role in solving problems on local and global issues (Kemendikbudristek, 2024). In addition, Dirawan (2023) and Istiqomah (2023) lso suggested that environmental knowledge taught to students can form an environmentally conscious attitude and change their behavior towards nature.

This study aims to measure the level of environmental knowledge of the 11th grade students in the Mahakam Delta region about the role of mangroves in mitigating climate change. The results of this environmental knowledge measurement are expected to serve as a diagnostic basis for designing effective environment-based learning, as well as identifying students' knowledge gaps. Thus, this research is not only academically relevant but also practical, supporting the formation of a generation that is responsive to environmental issues related to climate change.

METHOD

This research is a quantitative descriptive research with survey method. The research was conducted at State SHS 1 Anggana and State SHS 2 Muara Badak, Kutai Kartanegara Regency, East Kalimantan Province, which are located in the Mahakam Delta region. The population in this study were all the 11th grade students in the academic year of 2024/2025 with specialization in sciences subject, each of which amounted to 124 students from State SHS 1 Anggana and 140 students from State SHS 2 Muara Badak, so that the total population amounted to 264 students. The number of population and samples are presented in Table 1.

Table 1. The number of population and sample

Schools	Number of population	Number of sample
State SHS 1 Anggana	124	34
State SHS 2 Muara Badak	140	39
TOTAL	264	73

This study used a test technique to measure students' environmental knowledge about the role of mangroves in mitigating climate change in the Mahakam Delta region. The test instrument used was in the form of multiple-choice questions with four answer options, totaling 18 questions, as indicated in Table 2. The test instrument has been validated using content validity and criterion validity. The results of the content validity assessment conducted by experts indicated that all question items in the instrument were valid and aligned with the specified indicators. Meanwhile, the results of criterion validity analysis using point biserial correlation showed a strong correlation, indicating that all items in the test instrument were able to measure the same concept in different

students. The test instrument has also been tested for reliability using the test-retest method. The reliability test results were analyzed using the Kuder-Richardson-20 (KR-20) according to Supriadi (2021). The reliability test results of the test instrument show the KR 20 value = 0.86391, which means that the test instrument has good reliability and is consistent in measuring students' environmental knowledge.

Table 2. Indicators and sub-indicators of environmental knowledge

Number	Indicators	Sub-indicators
1.	Knowledge of ecology	Knowledge of global climate change Knowledge of mangrove potential Knowledge of the ability of mangroves to absorb carbon Knowledge of mangrove damage in the Mahakam Delta area
2.	Knowledge of environmental damage (analysis of cause, impacts, and environmental changes)	Knowledge of the impact of mangrove damage Knowledge of environmental changes on mangroves Knowledge of the impact of climate change
3.	Knowledge of problem solving related to environmental problems Knowledge of how to overcome environmental changes that occur due to damage in the Mahakam Delta area	Knowledge of actions that must be taken to overcome environmental changes that occur due to damage in the Mahakam Delta area Knowledge of the actions that must be taken to overcome environmental changes that occur due to damage in the Mahakam Delta area

The measurement results using the test instrument in the form of scores. The environmental knowledge score obtained for each student is then grouped based on the category according to Igbokwe (2016) in Khoirunnisa *et al.* (2023), as in Table 3.

Table 3. Environmental knowledge score category

Score	Category
$x > 80$	Very Good
$69 < x \leq 80$	Good
$59 < x \leq 69$	Fair
$49 < x \leq 59$	Poor
$x \leq 49$	Very Poor

Next, students were grouped by category and the frequency distribution for each category was calculated to provide an overview of the level of environmental knowledge of students in each different school.

RESULTS AND DISCUSSION

The results showed that the average environmental knowledge of students in the Mahakam Delta area regarding the role of mangroves in mitigating climate change as a whole was in the fair category with an average value of 61.62 (Table 4). This indicates that students' environmental knowledge about the role of mangroves in mitigating climate change is adequate in general, but not in depth. Students have knowledge about global warming and its impact on climate change, but do not know in depth that one of the causes of climate change is the impact of massive mangrove deforestation. However, there were differences in mean scores between the two schools studied. Students at State Senior High School 1 Anggana had an average environmental knowledge in the poor category with a mean score of 55.65, while students at State Senior High School 2 Muara Badak reached the fair category with a mean score of 67.59, indicating that students at State Senior High School 2 Muara Badak had better environmental knowledge about the role of mangroves in climate change mitigation compared to students at State Senior High School 1 Anggana.

Table 4. Average value of students' environmental knowledge

Number	Schools	Average value	Category
1	State SHS 1 Anggana	55.65	Poor
2	State SHS 2 Muara Badak	67.59	Fair
	Average	61.62	Fair

Based on the frequency distribution data in Figure 1, no students have reached the very good category, and 71% of students are still below the good category. This indicates a knowledge gap in environmental education, especially related to mangrove ecosystems and their role in climate change mitigation. Some of the factors that cause this low environmental

knowledge of students are the lack of integration of environmental knowledge about the role of mangroves in mitigating climate change in science learning at school. The issue of climate change has been included in the learning outcomes of the science phase E in the independent curriculum (Kemendikbud, 2016). But in reality, the integration of environmental knowledge, especially about coastal ecosystems such as mangroves, is often not a priority in science/chemistry learning in schools (Arisma *et al.*, 2025).

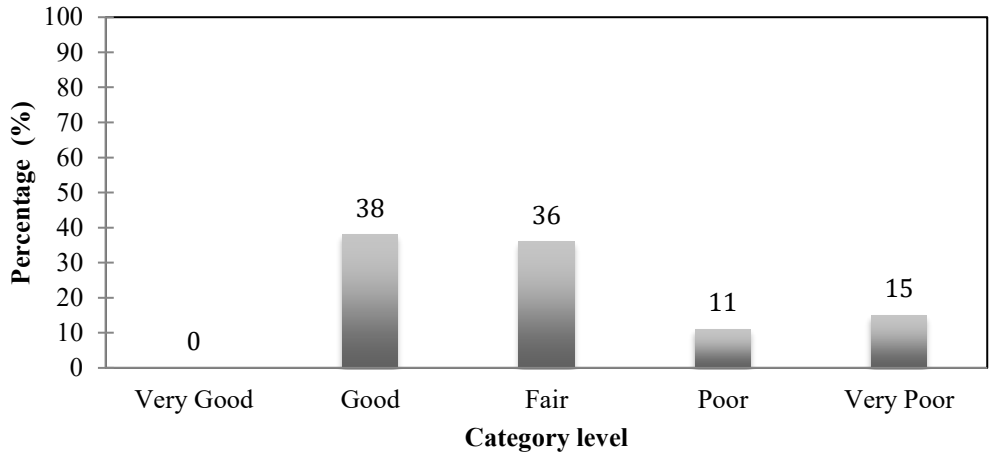

Figure 1. Frequency Distribution Diagram of Students' Environmental Knowledge Level

Sigit *et al*. (2019) found that students in the Jakarta, Bekasi, and Bogor areas had low knowledge of mangrove and coral reef conservation, as these materials were rarely discussed in depth at school. Arisma *et al*. (2025) also reported that the environmental issue of mangrove forest destruction, as one of the causes of climate change, is rarely discussed in science learning in schools located in the Mahakam Delta area. In addition, learning about climate change mitigation tends to be theoretical and does not involve hands-on learning with mangrove ecosystems (Istiqomah *et al*., 2025).

School location also affects students' environmental knowledge. The differences in frequency distribution data of students at State Senior High School 1 Anggana and State Senior High School 2 Muara Badak are presented in Table 5. The percentage of students who have environmental knowledge in the good category is higher in State Senior High School 2 Muara Badak (67%) than in State Senior High School 1 Anggana (3%). This indicates that students at State Senior High School 2 Muara Badak have better environmental knowledge about the role of mangroves in climate change mitigation compared to students at State Senior High School 1 Anggana.

Table 5. Differences in frequency distribution of students' environmental knowledge level between State Senior High School 1 Anggana and State Senior High School 2 Muara Badak

Number	Category level	State SHS 1 Anggana		State SHS 2 Muara Badak	
		Number of Students	Percentage (%)	Number of Students	Percentage (%)
1	Very Good	0	0	0	0
2	Good	1	3	27	69
3	Fair	18	53	8	21
4	Poor	7	21	1	3
5	Very Poor	8	24	3	8
	TOTAL	34	100	39	100

Based on the results of the independent samples t-test presented in Table 6, it can be concluded that there is a statistically significant difference between the two groups of students in

terms of their environmental knowledge outcomes. The analysis begins with Levene's Test for Equality of Variances to determine whether the variances of the two groups are equal. The significance value (Sig.) for Levene's Test is 0.071, which is greater than 0.05. This indicates that the variances between groups are considered homogeneous (equal), and therefore the t-test results can be interpreted using the first row (*Equal variances assumed*).

The calculated t-value is -4.466, with 71 degrees of freedom (df), indicating a substantial mean difference between the two groups. The 2-tailed significance value (Sig. 2-tailed) is 0.000, which is far below 0.05. This means the difference in means is highly statistically significant, and the null hypothesis (H_0), which states that there is no difference, is rejected. Thus, it can be concluded that there is a significant difference in students' environmental knowledge between the two groups being compared (possibly between two schools or two different treatments).

Table 6. T-test results

		Levenes's Test for Equality of Variances	**t-test for Equality of Means**				
Student' Knowledge Results		**Sig.**	**t**	**df**	**Sig. (2-tailed)**	**Mean Difference**	**Std. Error Difference**
	Equal variances assumed	.071	-4.466	71	.000	-11.94268	2.67396
	Equal variances not assumed		-4.394	62.403	.000	-11.94268	2.71820

Based on Figure 2, the location of State Senior High School 2 Muara Badak is only 11.71 meters from the mangrove forest area, while the location of State Senior High School 1 Anggana is in a densely populated area which is 32.97 meters from the mangrove area. The closer distance of the school location to the mangrove area can provide direct interaction between students and the ecosystem. This is why students at State Senior High School 2 Muara Badak who live in coastal areas or around mangrove areas have greater direct experience in experiencing the ecological functions of mangrove (Wicaksono et al., 2023). Direct experience can improve understanding of environmental concepts concretely because experience can help students to deepen knowledge about environmental phenomena around (Handiyati et al., 2023). In contrast, students who live far from coastal areas experience limitations in visualizing the role of mangroves directly, thus requiring a more visual or simulative learning approach.

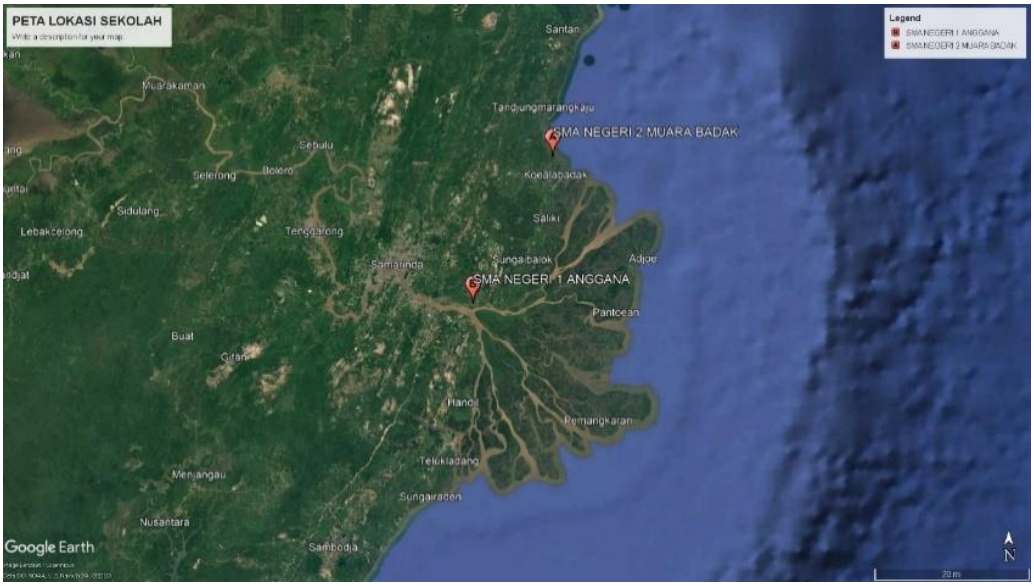

Figure 2. Differences in geographical location of State Senior High School 1 Anggana and State Senior High School 2 Muara Badak in the Mahakam Delta Region

Based on interviews with students at State Senior High School 2 Muara Badak, students have never been given material about climate change in science learning at school. However, because the location of their school and residence is very close to the mangrove area, they can see and feel firsthand the condition of mangrove ecosystems, both damaged and maintained, in the area. Therefore, the experience-based approach and geographical proximity are supporting factors that strengthen students' environmental knowledge..

However, the environmental knowledge of students at both State Senior High School 1 Anggana and State Senior High School 2 Muara Badak must be improved so that students can contribute to addressing environmental problems in the area where they live. Increasing students' environmental knowledge can be achieved through learning strategies that are more contextual, active, and based on the social-ecological reality around students. Marhamah (2021) argues that environmental education that is contextualized and involves students to play an active role through field projects or problem-based learning can increase students' knowledge and involvement in addressing environmental issues, including climate change mitigation through efforts to protect mangroves. Schools that are able to provide space for students to explore directly with mangrove ecosystems, such as mangrove planting activities, field studies, or collaboration with environmental communities, tend to produce students who not only understand cognitively, but are also emotionally and socially involved in nature conservation.

CONCLUSION AND SUGGESTIONS

Conclusion

Based on the results of the environmental knowledge test on the 11th grade students in the Mahakam Delta area about the role of mangroves in mitigating climate change, it shows that overall students have environmental knowledge in the fair category.

Suggestion

To enhance future research and address these gaps, future studies should include a wider demographic range, such as students from different grade levels, schools in both coastal and inland areas, and varying socioeconomic backgrounds. This will help determine whether knowledge gaps are localized or systemic. Additionally, incorporating teachers' and community perspectives could provide deeper insights into curriculum effectiveness and cultural influences on environmental awareness.

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