



Analysis of Environmental Literacy among Students at MAN 2 Tuban

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Abstract: This study aimed to analyze the environmental literacy level of students at MAN 2 Tuban based on four aspects: ecological knowledge, cognitive skills, environmental attitudes, and environmental behavior. A quantitative descriptive research design was employed. The sampling technique used was simple random sampling, involving 66 eleventh-grade students as the research sample. Data were collected through tests and surveys. The research instruments consisted of multiple-choice questions to assess ecological knowledge and cognitive skills, and an environmental literacy questionnaire adapted from the Middle School Environmental Literacy Survey to measure students' environmental attitudes and behavior. The findings indicated that students' ecological knowledge and cognitive skills were lower than their environmental attitudes and behavior. Overall, 77.27% of students were categorized as having a moderate level of environmental literacy, while 22.73% were categorized as having a high level. The mean scores for each aspect were 57 for ecological knowledge, categorized as fair; 51 for cognitive skills, categorized as fair; 69 for environmental attitudes, categorized as high; and 61 for environmental behavior, categorized as high. These results reveal an imbalance between students' conceptual understanding and their environmental attitudes and behavioral tendencies. Therefore, learning strategies that place greater emphasis on strengthening cognitive aspects are needed to ensure alignment between students' knowledge, attitudes, and behavior toward the environment.

Keywords: Environmental literacy; madrasah; learning

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INTRODUCTION

Environmental issues have become a global concern because they affect human life and ecosystems, including in Indonesia (Uyun & Suhartini, 2024). These issues include global warming, acid rain, environmental pollution, natural degradation, and biodiversity loss (Lai & Lai, 2018; Mitsuyuki, 2017). Such environmental problems may arise from natural factors or human activities. Human activities, including increasing electricity consumption, industrial production, transportation, waste management, and agriculture, have contributed to various environmental challenges (Filonchik et al., 2024). Climate change can also intensify extreme weather events, such as droughts and floods, increase global temperatures that may trigger forest fires, and create increasingly unpredictable weather patterns (Bolan et al., 2024; Clarke et al., 2022).

In daily life, humans engage in various activities that can negatively affect environmental balance. Irresponsible human actions often exert the greatest influence on environmental change (Wu et al., 2023). In Indonesia, low levels of environmental concern may also be associated with limited environmental awareness. Everyday human activities continue to contribute to environmental degradation and disrupt ecological balance (Pangestu et al., 2023). Environmental damage can be reduced when communities possess strong awareness and adequate knowledge of how to address environmental problems (Karmana, 2023). Education is therefore an important

pathway for promoting behavioral change toward the environment (Conde & Samuel Sánchez, 2010; Derevenskaia, 2014; Ozsoy et al., 2012). It plays a crucial role in increasing awareness of environmental issues and contributing to solutions for existing environmental problems (Kahyaoğlu, 2014). Environmental education is not only intended to shape individuals' ways of thinking and understanding the world, but also to foster intrinsic motivation to behave responsibly in real-life contexts (Otto & Pensini, 2017). The primary objective of environmental education development is to promote environmental literacy (Saribas, 2015).

Environmental literacy refers to an understanding of the relationship between humans and the environment, as well as the ability to act in ways that support ecosystem sustainability. It is associated with ecological knowledge, awareness, sensitivity, and responsibility regarding the impacts of human activities on natural resources (Derman et al., 2016). Environmental literacy integrates knowledge, attitudes, and behavior to prevent and solve environmental problems (Kaya & Elster, 2018). It also emphasizes the importance of environmental awareness and participation in environmental action (Guerrero & Sjöström, 2024). Individuals are considered environmentally literate when they possess understanding, knowledge, character, values, ethics, and skills related to preventing environmental problems, as well as the motivation to protect and improve environmental quality both in the present and in the future (Shamuganathan & Karpudewan, 2015). The main components of environmental literacy include ecological knowledge, cognitive skills, environmental attitudes, and environmental behavior (MSELS, 2012).

Environmental literacy among students is a competency that needs to be optimized so that they can support sustainable development and contribute to the protection of nature (Derman et al., 2016; Kaya & Elster, 2018; Veisi et al., 2019). Otto & Pensini (2017) stated that environmental experiences during childhood and adolescence are strongly correlated with environmentally friendly behavior in adulthood. Therefore, students should not be viewed merely as recipients of environmental education, but also as potential agents of change in efforts to achieve environmental sustainability. Empirical findings indicate that the environmental literacy of Indonesian students still needs to be improved through appropriate and effective approaches. One strategic effort to achieve this goal is to strengthen the role of the education sector (Hermawan et al., 2022). Individuals with environmental literacy tend to develop a mindset that is caring and responsive toward their surroundings. This is supported by findings showing that environmental literacy can shape a mindset that is attentive and responsive to environmental conditions (Miterianifa & Mawarni, 2024; Pangestu et al., 2023). Environmental literacy also helps develop a generation that understands the importance of preserving and protecting the natural environment for the sustainability of life on Earth (Mustofa & Sueb, 2023).

Studies on students' environmental literacy in Indonesia have reported varied results. Aini et al. (2020) found that the environmental literacy of students at SMAN 3 Jombang was in the moderate category, with an average score of 75. More specifically, the knowledge indicator was categorized as good, with an average score of 80, whereas cognitive skills, attitudes, and behavior were categorized as moderate, with average scores of 75, 74, and 72, respectively. Similarly, Utami et al. (2023) reported that the overall environmental literacy of students at SMAN 10 Palembang was 49.06%, placing it in the moderate category. However, certain indicators, particularly knowledge at 39.44% and cognitive skills at 29.52%, were categorized as poor, whereas behavior at 60.94% was categorized as fairly good, and the affective indicator at 66.33% was categorized as good. In contrast, Azizah & Roshayanti (2024) showed

that the overall environmental literacy level of Grade X students at SMKN 1 Ampelgading was low, with an average percentage score of 40%. Another study by Maghfiroh et al. (2024) found that the environmental literacy of Grade XI science students at Adiwiyata senior high schools in Semarang City was moderate in terms of knowledge, cognitive skills, and attitudes, with average scores of 35, 37, and 45, respectively. These findings indicate disparities across environmental literacy indicators. Some studies show that affective and behavioral aspects are stronger than knowledge and cognitive skills, whereas others report low achievement across all aspects.

Although various studies on environmental literacy have been conducted, research examining environmental literacy in madrasah-based schools remains limited. Madrasahs have distinctive characteristics because they integrate general education with religious education, emphasizing not only cognitive development but also the formation of students' values, morals, and character. A religious educational environment has been shown to play a role in character formation and value internalization among students, including the development of responsibility and care (Habibah & Farih, 2025). The integration of religious values may therefore serve as a foundation for strengthening pro-environmental attitudes and behavior.

The importance of examining environmental literacy in madrasahs is also based on the fact that their characteristics differ fundamentally from those of general schools, such as senior high schools and vocational high schools. Research has shown that students' environmental literacy achievement is strongly influenced by learning processes and the school environment, including the values and culture developed within the school community (Baiah & Fadiana, 2024). Studies conducted in madrasahs indicate the presence of a specific environmental literacy profile, with variations in achievement across knowledge, skills, attitudes, and behavior depending on the educational approach used (Wulandari & Roshayanti, 2022). Therefore, findings from studies conducted in general schools cannot be directly generalized to madrasahs because of differences in educational approaches, value systems, and school culture.

Research on the environmental literacy profile of madrasah students based on the four dimensions of environmental literacy remains limited, although these dimensions are essential and interrelated components of environmental literacy. Therefore, this study aims to analyze the environmental literacy level of students at MAN 2 Tuban. This study contributes to the development of environment-based learning strategies designed to improve students' environmental knowledge, cognitive skills, attitudes, and behavior in madrasah contexts.

METHOD

This study employed a quantitative descriptive research design. The population comprised all Grade XI students at MAN 2 Tuban, totaling 347 students. The sample size was determined using the Slovin formula with a 10% margin of error, resulting in 66 respondents. The sampling technique used was simple random sampling, in which Grade XI students were selected randomly without considering the proportional distribution of students across classes.

The data collection instruments consisted of a test and a questionnaire. The test was administered in the form of multiple-choice questions to measure ecological knowledge and cognitive skills. It consisted of 30 items, comprising 20 items on ecological knowledge and 10 items on cognitive skills. The questionnaire was used to measure environmental attitudes and environmental behavior and consisted of 40

statements, comprising 30 statements on environmental attitudes and 10 statements on environmental behavior.

Instrument validity was tested using Pearson's correlation test, with each item considered valid when its significance value was less than 0.05 ($p < 0.05$). The validity test results for the ecological knowledge, cognitive skills, environmental attitudes, and environmental behavior aspects showed significance values below 0.05 for all items. These results indicate that all items in the instruments were valid. Instrument reliability was then assessed using Cronbach's alpha. An instrument was considered reliable when the Cronbach's alpha value exceeded 0.60. The Cronbach's alpha values for all aspects were greater than 0.60, indicating that the items comprising each aspect of the instrument were reliable.

Environmental literacy data were collected using two types of instruments. The environmental literacy test, consisting of multiple-choice questions, was used to assess ecological knowledge and cognitive skills. Meanwhile, the environmental literacy questionnaire was used to assess environmental attitudes and environmental behavior. The questionnaire was adapted from the Middle School Environmental Literacy Survey (MSELS, 2012). It was a closed-ended questionnaire using a five-point Likert scale. The aspects and indicators of environmental literacy are presented in Table 1.

Table 1. Aspects and indicators of environmental literacy

Aspect of Environmental Literacy	Indicator
Ecological knowledge	Ecological knowledge
Cognitive skills	Identification of environmental issues
	Analysis of environmental issues
	Environmental action plan
Environmental attitudes	Intention to act
	Environmental sensitivity
	Feelings toward the environment
Environmental behavior	Actual commitment

Source: MSELS (2012)

The environmental literacy measurement data were analyzed descriptively to determine students' environmental literacy levels. The categorization of environmental literacy levels is presented in Table 2.

Table 2. Categories of environmental literacy levels

No.	Criterion	Score Range
1	Low	40–160
2	Moderate	161–280
3	High	281–400

Source: Adapted from MSELS (2011)

RESULTS AND DISCUSSION

Students' Environmental Literacy

The percentage distribution of environmental literacy among Grade XI students at MAN is presented in Table 3. The data show that most students were in the

moderate category (77.27%), while 22.73% were in the high category. These findings indicate the need for further efforts to improve students' environmental literacy to a more optimal level.

Table 3. Students' environmental literacy

No.	Criteria	Score Range	Number of Students	Percentage (%)
1	Low	40–160	0	0.00
2	Moderate	161–280	51	77.27
3	High	281–400	15	22.73

Environmental literacy consists of four aspects: ecological knowledge, cognitive skills, environmental attitudes, and environmental behavior. The mean scores for each component are shown in Table 4.

Table 4. Mean scores of students' environmental literacy

No.	Aspect of Environmental Literacy	Mean Score	Criteria
1	Ecological knowledge	57	Fair
2	Cognitive skills	51	Fair
3	Environmental attitudes	69	High
4	Environmental behavior	61	High

The mean scores in Table 4 indicate that students demonstrated fair achievement in ecological knowledge and cognitive skills, whereas their environmental attitudes and behavior were in the high category. These results support the overall classification of students' environmental literacy as predominantly moderate, which appears to be influenced by relatively low achievement in ecological knowledge and cognitive skills. This finding is consistent with previous research showing that environmental literacy comprises several main components, namely knowledge, cognitive skills, attitudes, and behavior, which do not always develop at the same level. Sari et al. (2025) found that environmental literacy may be categorized as high overall, while still showing variation across components, with affective aspects often being more dominant than cognitive aspects.

However, the findings of this study differ from studies suggesting that ecological knowledge is a fundamental component of environmental literacy because positive attitudes and behavior are assumed to result from sound knowledge (Sunarto, 2023). Cognitive skills also play a role in shaping attitudes and habits that require higher-order thinking and problem-solving abilities (Szczytko et al., 2019). Environmental knowledge provides a foundation for developing positive environmental attitudes, which in turn influence pro-environmental intentions and behavior (Liu et al., 2020).

From the perspective of the Theory of Planned Behavior, behavior is not directly influenced by knowledge. Instead, knowledge may operate through mediating variables such as attitudes, subjective norms, and perceived behavioral control, which shape intention before being translated into action. Zaikauskait et al. (2023) showed that the relationship between knowledge and behavior is often indirect because it is mediated by psychological and social factors. In addition, Khan et al. (2025) reported that social norms and individuals' perceptions of their environment have a significant influence on the formation of pro-environmental behavior, even more strongly than knowledge. This suggests that individuals may display positive environmental behavior

because of social encouragement, not solely because of strong conceptual understanding.

The environmentally responsible behavior of madrasah students is likely influenced by social norms and school culture, such as cleanliness rules and habituation practices implemented by teachers and school administrators. Vicente-Molina et al. (2013) showed that social environments and educational institutions play an important role in shaping environmental behavior through habituation and reinforcement of norms. Family factors also contribute to students' behavior. Values instilled at home, such as maintaining cleanliness and caring for the environment, may shape behavior even when students' level of knowledge is not yet optimal. Monroe et al. (2017) stated that direct experiences and the influence of the immediate environment are key factors in the development of environmental behavior among adolescents.

Attitudes and behavior are not formed instantly but are influenced by multiple interacting factors. Ofori et al. (2023) stated that personal experience is one of the most significant factors in shaping individuals' environmental attitudes and behavior. Students' environmental attitudes and behavior result from the interaction of educational, experiential, cultural, social, and political factors (Braun et al., 2018). The present study shows that positive attitudes and behavior do not always arise from strong knowledge. Rather, the environmental attitudes and behavior observed in this study appear to be influenced more strongly by external factors, including education, experience, culture, and society.

Ecological Knowledge

Table 5 presents the percentage distribution of students' ecological knowledge. As shown in the table, 3.03% of students were in the very low category, 22.73% were in the low category, 36.36% were in the fair category, 24.24% were in the high category, and 13.64% were in the very high category.

Table 5. Students' ecological knowledge

No.	Score Range	Category	Number of Students	Percentage
1	0–20	Very low	2	3.03%
2	21–40	Low	15	22.73%
3	41–60	Fair	24	36.36%
4	61–80	High	16	24.24%
5	81–100	Very high	9	13.64%

Andiasari (2022) stated that ecosystem material is multidisciplinary, complex, and closely related to other biological concepts, making it challenging to understand and potentially causing cognitive overload. Biogeochemical cycles are part of ecosystem material. According to Cahyani et al. (2025), biogeochemical cycles are complex because they involve chemical processes and interactions among chemical elements in the environment. This complexity may confuse students who lack sufficient foundational knowledge in biology and chemistry.

The complexity of biogeochemical cycles is one factor that may explain students' relatively low achievement in ecological knowledge. This is reflected in the mean ecological knowledge score of MAN 2 Tuban students, which was in the moderate category. Understanding biogeochemical cycles requires not only memorization but also the ability to integrate biological and chemical concepts simultaneously.

Therefore, students without strong foundational knowledge may find it difficult to understand these concepts comprehensively.

This condition may be further reinforced by learning practices that generally remain focused on theoretical content delivery, limiting students' opportunities to engage in contextual learning experiences. As a result, students may struggle to develop conceptual representations of abstract processes, such as the carbon and nitrogen cycles. This is consistent with Wang et al. (2023), who found that students often have difficulty visualizing phenomena in biogeochemical cycles, leading to incomplete or even inaccurate conceptual models. Classroom learning has not fully engaged students actively in asking questions, participating in discussions, or developing ideas independently. Passive learning methods do not encourage students to construct their own knowledge actively and are therefore less effective in improving their basic understanding of ecosystem material and environmental change (Rea et al., 2022).

Cognitive Skills

The cognitive skills measured in this study included the ability to identify environmental issues, analyze environmental issues, and plan environmental actions. The percentage distribution of students' cognitive skills is presented in Table 6. Based on the data, 12.12% of students were in the very low category, 24.24% were in the low category, 39.39% were in the fair category, 18.18% were in the high category, and 6.06% were in the very high category.

Table 6. Students' cognitive skills

No.	Score Range	Category	Number of Students	Percentage
1	0–20	Very low	8	12.12%
2	21–40	Low	16	24.24%
3	41–60	Fair	26	39.39%
4	61–80	High	12	18.18%
5	81–100	Very high	4	6.06%

The findings show that students' mean cognitive skills score was in the moderate category. Environmental literacy does not merely involve reading and writing information; it also includes understanding environmental concepts and the ability to interpret scientific information related to environmental issues (Rokhmah et al., 2021). Information in texts should serve as a guide for students in identifying problems, analyzing issues, and planning steps to solve environmental problems (McBeth & Volk, 2009). Low cognitive skills may result from insufficient foundational knowledge of ecology and biogeochemical cycle concepts. Basic ecological knowledge is an important element in developing environmental problem-solving skills (Prastiwi et al., 2019). This is also consistent with Suryawati et al. (2020), who stated that foundational knowledge influences thinking skills, which in turn may affect action and increase individual sensitivity.

The results indicate that students' cognitive skills remain at a moderate level, suggesting that higher-order thinking skills have not yet developed optimally. Cognitive skills are also related to learning characteristics that have not fully accommodated the development of higher-order thinking skills (HOTS). Instruction that focuses mainly on information delivery may limit students' involvement in exploration, analysis, and problem-solving processes. Previous studies have shown that higher-order thinking

skills can develop significantly when students are engaged in problem-based learning, which places them in real-world situations and requires them to analyze problems and formulate solutions (Akbar, 2025; Arviani et al., 2023). Low cognitive skills may also occur because students are not yet accustomed to identifying problems, analyzing issues, and planning appropriate actions, either in classroom learning or in daily life (Cahyani et al., 2025). Thus, the findings of this study not only show that complex subject matter poses a learning challenge but also indicate that the instructional strategies used have not fully supported the development of higher-order thinking skills.

Environmental Attitudes and Behavior

The aspects of environmental attitudes measured in this study included intention to act, environmental sensitivity, and feelings toward the environment. Table 7 presents the percentage distribution of students' environmental attitudes. The results show that 12.12% of students were in the fair category, 78.79% were in the high category, and 9.09% were in the very high category. These findings indicate that students had a strong commitment to protecting the environment, high levels of concern, and positive feelings toward the environment.

Table 7. Students' environmental attitudes

No.	Score Range	Category	Number of Students	Percentage
1	0–20	Very low	–	–
2	21–40	Low	–	–
3	41–60	Fair	8	12.12%
4	61–80	High	52	78.79%
5	81–100	Very high	6	9.09%

The aspect of environmental behavior measured in this study was actual commitment. The results are presented in Table 8, which shows that 3.30% of students were in the low category, 42.42% were in the fair category, 51.52% were in the high category, and 3.30% were in the very high category. These findings suggest that most students demonstrated actual commitment to environmental behavior, as the majority were distributed across the fair and high categories.

Table 8. Students' environmental behavior

No.	Score Range	Category	Number of Students	Percentage
1	0–20	Very low	–	–
2	21–40	Low	2	3.30%
3	41–60	Fair	28	42.42%
4	61–80	High	34	51.52%
5	81–100	Very high	2	3.30%

These findings indicate that students' environmental attitudes reflect internal tendencies, such as awareness, sensitivity, and intention to act, but these attitudes are not necessarily translated consistently into actual behavior. According to the Theory of Planned Behavior, attitude is one factor that shapes an individual's intention to act. However, behavior is also influenced by social pressures from the surrounding environment and by individuals' beliefs about their ability to perform the behavior.

Therefore, even when students have positive attitudes and intentions, pro-environmental behavior may not emerge if it is not supported by habits, facilities, and social influences.

Zaikauskait et al. (2023) showed that the relationship between attitudes and behavior is not always linear because it may be mediated by factors such as self-control and environmental conditions. Colombo et al. (2023) also described the existence of an attitude–behavior gap, namely the discrepancy between positive environmental attitudes and inconsistent actual behavior. Otto and Pensini (2017) showed that pro-environmental behavior among adolescents is influenced by repeatedly formed habits and direct experience, rather than by attitudes or knowledge alone. This argument is further supported by Whitburn and Linklater (2019), who emphasized that the availability of facilities and support from the social environment play an important role in helping individuals translate attitudes into concrete actions.

CONCLUSION

The environmental literacy level of students at MAN 2 Tuban, based on a total sample of 66 students, showed that 77.27% were in the moderate category and 22.73% were in the high category. The students' mean environmental literacy scores were 57 for ecological knowledge (moderate), 51 for cognitive skills (moderate), 69 for environmental attitudes (high), and 61 for environmental behavior (high). These findings indicate that students' ecological knowledge and cognitive skills were lower than their environmental attitudes and behaviors.

This imbalance between conceptual understanding and students' attitudinal and behavioral tendencies suggests the need for learning strategies that place greater emphasis on strengthening cognitive aspects so that they are aligned with students' positive environmental attitudes and behaviors. The findings further imply that future studies should examine learning models that can balance cognitive aspects with environmental attitudes and behaviors, as well as investigate factors such as school culture, habituation practices, and religious values that may influence students' environmental literacy.

RECOMMENDATION

Based on the findings, environmental education should place greater emphasis on strengthening students' ecological knowledge and cognitive skills while maintaining their positive environmental attitudes and behaviors. Teachers are encouraged to apply active learning approaches, such as problem-based or project-based learning, to help students understand ecological concepts and solve environmental problems. Future studies should further examine learning models and contextual factors, including school culture, habituation practices, and religious values, that may influence students' environmental literacy.

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