Architecture
Image Studies

Vol.6, Issue 4, pp.1233-1251, 2025
DOI: https://doi.org/10.62754/ais.v6i4.743

https://journals.ap2.pt/index.php/ais/index

Faith-Based Environmental Education: The Role of Ecotheology in Developing Ecoliteracy among Muslim Boarding Students

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Abstract

Indonesia is currently facing a serious environmental crisis driven by increasingly exploitative human behavior. Environmental education has the potential to be integrated into various forms of education, including non-formal education such as Islamic boarding schools (pondok pesantren). As educational institutions that not only teach religious knowledge but also cultivate social values and character, pesantren hold significant potential for instilling environmental awareness and care based on Islamic teachings. One concept that is highly relevant in this context is ecotheology. Ecotheology is a form of constructive theology that explains the relationship between religion and the environment. Within ecotheology, the principles of tawhid, creation (khalq), balance (mizan), and the trust of stewardship (amanah khalifah) affirm that humans are obliged to protect Allah's creation. Ecotheology plays an important role in fostering environmental awareness and concern by promoting education, advocacy, action, and funding for ecological management. Pondok Pesantren Fadhlul Fadhlan implements the concept of an "eco-pesantren" as an effort to equip students (santri) with both religious knowledge and practical skills. The integration of ecotheological teachings and ecoliteracy through concrete environmental care practices has a positive impact on the pro-environmental behavior of students at Pondok Pesantren Fadhlul Fadhlan. Therefore, applying ecotheology within the learning process is crucial for enhancing environmental awareness and concern. This study employs a quantitative research approach with a survey method. It focuses on analyzing the level of ecotheology-based environmental perception and the level of ecoliteracy among students of Pondok Pesantren Fadhlul Fadhlan in Semarang City. The research was conducted at Pondok Pesantren Fadhlul Fadhlan, with participants consisting of 90 junior high school students and 105 senior high school students, totaling 195 participants. The data sources comprise both primary and secondary data. Data were analyzed using SmartPLS 4 with the Partial Least Squares Structural Equation Modeling (PLS-SEM) technique and Multiple Group Analysis (MGA) Bootstrapping, aiming to maximize the R-square value and minimize residuals or prediction errors. The findings indicate that the substantive integration of ecotheology significantly enhances students' environmental literacy. The ecotheological approach operationalizes religious principles—particularly those embodied in the indicator of tawhid—within ecological concepts, thereby enabling students to understand their responsibility to protect nature as an integral part of religious practice. The implementation of ecotheology nurtures cognitive, affective, and behavioral dimensions that are oriented toward sustainable environmental care.

Keywords: *Eco-pesantren; ecoliteracy; Islamic ecotheology; environmental education; Islamic boarding school.*

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Introduction

Indonesia is currently facing a complex environmental crisis driven by increasingly exploitative human behavior [1-7]. Environmental education has become highly urgent as a means to realize concrete environmental conservation efforts amid escalating ecological degradation [8-10]. Education contributes to shaping awareness, character, and positive mindsets regarding the environment, enabling communities to adopt more sustainable lifestyles [11]. Environmental education is a process of developing awareness, knowledge, understanding, critical attitudes, problem-solving and decision-making skills, responsibility, and positive attitudes toward the environment, as well as practical competencies that equip individuals to play an active role in maintaining environmental quality [12-14].

Environmental education has the potential to be implemented across various educational settings, including non-formal institutions such as Islamic boarding schools (pondok pesantren). As educational institutions that go beyond the mere transmission of religious knowledge, pesantren have considerable potential for cultivating social values and character [15-17], including environmental responsibility. This potential lies in the substantive nature of pesantren education, which emphasizes the internalization of religious knowledge, social values, and moral conduct [18,19]. The residential model of pesantren, where students (santri) live on campus 24 hours a day, further supports the direct implementation of environmental knowledge and values in daily life [20].

As Islamic educational institutions, pesantren are well positioned to instill environmental concern grounded in Islamic teachings. One particularly relevant concept in this context is ecotheology, a form of constructive theology that examines the relationship between religion and the environment [21]. Ecotheology has long been used to articulate Islamic teachings on environmental conservation as a form of environmental education since the late 1960s [22-26]. At its core, ecotheology is based on the awareness that environmental crises are not merely secular issues, but also serious religious problems arising from misunderstandings of religious teachings about life and nature [27]. Ecotheology examines the relationship between religion and the natural world, particularly in relation to environmental issues, and seeks to make the presence of God meaningful within ecological discourse [28]. Within ecotheology, the principles of oneness of God (*tawhid*), creation (*khalq*), balance (*mizan*), and the mandate of stewardship (*amanah khalifah*) serve as fundamental doctrines affirming that humans are obliged to protect Allah's creation [21,29]. Religion thus has the capacity to provide the conceptual framework necessary for ecological preservation [30], making ecotheology an essential component of religious teaching that should be promoted to prevent future environmental disasters.

The concept of ecotheology emerges as a response to the need for a holistic approach that balances human needs with environmental preservation, rooted in spiritual and moral values derived from religion [31]. As an interdisciplinary field that integrates theological or spiritual principles with environmental concerns, ecotheology has made a significant contribution to environmental education [32]. It plays a vital role in fostering environmental awareness and concern by promoting education, advocacy, concrete actions, and resource mobilization for ecological management [33]. Knowledge is a key factor in shaping environmental awareness [34], and ecotheological education is important for understanding the relationship between religious beliefs, ethical values, and environmental responsibility [35]. The implementation of environmental education has been shown to positively influence students' environmental knowledge and awareness [36], reinforcing the importance of integrating ecotheology into learning processes to enhance environmental consciousness and concern.

Pondok Pesantren Fadhlul Fadhlan is not merely a traditional pesantren. It integrates classical Islamic education—such as salaf-based learning, Quran memorization (*tahfîzh*), and the study of classical texts (*kitab kuning*)—with the use of Arabic and English as languages of instruction, as well as programs fostering self-reliance in food production and the economy through agricultural, livestock, entrepreneurial, and halal production units. This profile positions Pondok Pesantren Fadhlul Fadhlan as a concrete example of an eco-pesantren, where religious values, education, and environmental awareness are combined within the daily lives of the students. Such characteristics make it highly relevant as a research site for examining the influence of ecotheology on ecoliteracy and pro-environmental behavior.

The pesantren implements the eco-pesantren concept as a means of equipping students with both religious knowledge and practical skills. The integration of ecotheological teachings and ecoliteracy through environmental care practices has a positive impact on the environmental responsibility of its students and encourages the internalization of ecotheology and, especially, ecoliteracy as outcomes of this integrated framework. This integration has the potential to strengthen environmentally responsible

behavior as an expression of faith and ecological piety in the students' everyday lives. Therefore, this study aims to analyze the level and influence of ecotheology-based environmental perceptions on ecoliteracy among students at Pondok Pesantren Fadhlul Fadhlan.

Literature Review

Ecotheology is not a recently emerged concept; it has been discussed since the late 1960s. However, studies examining pro-environmental behavior in society still rarely employ ecotheology as an indicator or conceptual framework, particularly in relation to its influence on ecoliteracy in general. Previous research has indeed incorporated variables related to spirituality, yet only a few have explicitly and rigorously utilized an Islamic ecotheology framework. Earlier studies tend to address Islamic ecotheology at a general theoretical level without detailing its integration with ecoliteracy measures or outcomes [37,38]. Furthermore, although numerous studies have analyzed pro-environmental behavior among students in Islamic boarding schools, they have not adopted an ecotheological framework as their primary analytical lens, as exemplified by the work of Nurkhin et al. (2023) [39].

Only a limited number of studies, such as those by Kurniawan and Syifauddin (2021) and Suharini et al. (2024) [40,41], have specifically explored Islamic ecotheology in the context of pesantren and ecoliteracy. These studies begin to connect ecological aspects in Islam with ecological awareness, but their discussions remain largely conceptual and have yet to develop instruments that specifically measure the internalization of Islamic ecotheology. In addition, their focus is more oriented toward value transformation and religious understanding within particular communities, without quantitatively testing the relationship between ecotheological understanding and environmental literacy among learners or the broader community. Most previous research has concentrated on environmental attitudes or awareness, offering limited comprehensive explanation of Islamic ecotheology as a concept. Within the pesantren setting, the assimilation of religious principles often serves as a fundamental basis for shaping students' behavioral patterns. The absence of a clear theoretical framework linking Islamic ecotheology with enhanced ecoliteracy and pro-environmental behavior underscores the importance of the present study, both for advancing theoretical discourse and for informing practical implementation of religiously oriented environmental education grounded in spiritual principles.

By formulating operational indicators of Islamic ecotheology and empirically assessing their impact on ecoliteracy dimensions and ecological behavior, this study aims to enrich scientific perspectives and provide a robust academic basis for strengthening environmental education programs in faith-based institutions, particularly Islamic boarding schools. The expectation is that this research will not only address the cognitive dimension but also foster a concrete and sustainable pro-environmental behavioral paradigm rooted in ecotheological values.

Methodology

Research Design

This study employed a quantitative research approach with a survey method. It focused on analyzing the level of ecotheology-based environmental perception and the level of ecoliteracy among students of Pondok Pesantren Fadhlul Fadhlan in Semarang, as well as examining the influence of ecotheology-based environmental perception on ecoliteracy. The values of Islamic ecotheology were analyzed through four main dimensions: (1) the principle of Tawhid, (2) the principle of Amanah–Khilafah, (3) the principle of Khalq, and (4) the principle of Mizan [42]. Ecoliteracy among students was measured using an environmental literacy instrument grounded in spirituality, consisting of four core dimensions: (1) ecological knowledge, (2) environmental hope, (3) cognitive skills, and (4) behavior [43].

Participants

The research was conducted at Pondok Pesantren Fadhlul Fadhlan in Semarang City. The participants were students (santri) of Pondok Pesantren Fadhlul Fadhlan, consisting of 90 junior high school (SMP) students and 105 senior high school (SMA) students, for a total of 195 participants. Sampling was carried out in Grade 9 for the junior high school level and in Grades 10 and 12 for the senior high school level. These classes were selected because the students had attended the pesantren for more than two years.

Data Sources and Data Collection Techniques

The data comprised primary and secondary sources. Primary data were obtained directly from field research. In this study, primary data were collected using a questionnaire to gather information on the

values of Islamic ecotheology and the level of ecoliteracy among students in the pesantren. The questionnaire was constructed using a Likert scale ranging from 1 to 5 and consisted of 46 items.

Data Analysis

The questionnaire and observation data were entered into Microsoft Excel for tabulation, coding, and classification according to variables and indicators, then saved in CSV format. The dataset was subsequently exported into SmartPLS 4 for analysis using Partial Least Squares Structural Equation Modeling (PLS-SEM) with Multiple Group Analysis (MGA) Bootstrapping. This procedure aimed to maximize the R-square value and minimize residuals or prediction errors [44], as well as to determine the significance level of each hypothesis for each educational level group. The analysis was carried out in two stages.

Full Model Analysis

At this stage, the full model was analyzed and evaluated, with each construct specified as a first-order CFA. Model evaluation covered both the outer model and the inner model. The outer model evaluation for each construct (measurement model) was conducted separately through assessments of convergent validity, discriminant validity (HTMT, Fornell–Larcker criterion, and cross-loadings), and internal consistency reliability (composite reliability and Cronbach's alpha). The inner model evaluation considered three aspects: the magnitude and direction of path coefficients, the significance of the estimated parameters, and the coefficients of determination (R^2) and effect sizes. If the outer model testing indicated that certain constructs were invalid or unreliable, the model was revised (re-specified) by eliminating those constructs. The moderating variable was evaluated only within the inner model by comparing p-values (< 0.05) using the bootstrapping method.

Model Comparison Across Groups

In the second stage, the models for the two groups were compared descriptively and through t-tests for each educational level (junior and senior high school; SMP and SMA). In addition to identifying the p-values of the model for each group, this stage also examined the magnitude of differences between the groups.

The specification of the construct model used in this study is presented in Figure 1 as the initial research model.

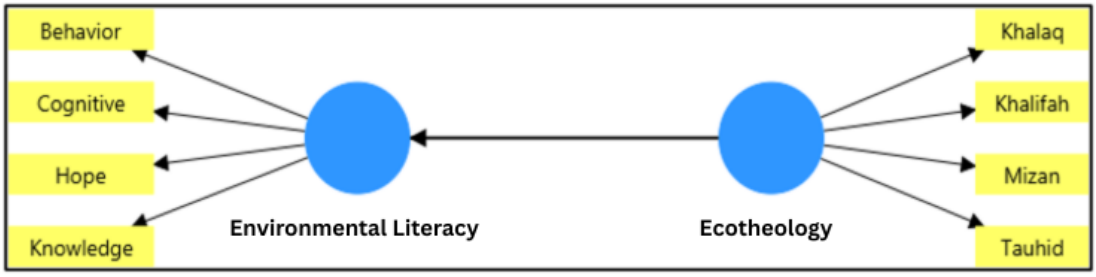

Figure 1. Initial Research Model

Results and Discussion

Respondent Profile

The sample in this study consisted of 90 students at the junior high school (SMP) level and 105 students at the senior high school (SMA) level, as summarized in Table 1.

Table 1. Respondent Overview

Demography		SMP		SMA	
		N	N (%)	N	N (%)
Gender	Males	47	52.22	53	58.89
	Females	43	47.78	52	57.78
Age	<15 years	57	63.33	4	3.81
	15 - 17 years	33	36.67	96	91.43

	> 17 years	-	-	5	4.76
Total		90	100	105	100

The respondents were selected from Grade 9 (SMP) and Grades 10 and 12 (SMA), with the criterion that they had studied at the pesantren for more than two years. The distribution in Table 1 indicates that the number of male and female respondents is relatively balanced at both levels. At the SMP level, respondents' ages range from 13 to 16 years, while at the SMA level they range from 14 to 19 years, with the majority falling between 15 and 17 years. The subsequent analyses present the characteristics of the study variables for each level and for the overall sample.

Distribution of Respondents' Answers

The distribution of respondents' answers was analyzed descriptively to capture their overall perceptions based on the variables used in this study. Descriptive analysis was carried out by calculating the frequency of responses for each questionnaire item, as well as the mean score for each indicator and research variable. The resulting mean scores were then interpreted into three categories: low, medium, and high. Referring to Levine, Stephan, Krehbiel, and Brenson (2011) [45], interval scales were determined for the five-point Likert scale used in all items.

$$K = \frac{5-1}{3} = 1{,}33$$

Table 2. Interpretation of Mean Category Kategori Mean

Mean Value	Description
1 – 2,33	Low
2,34 – 3,66	Medium
3,67 – 5	High

Source: Processed Data, 2025

Distribution of Answers on the Environmental Variable

The distribution of respondents' answers for the environmental variable is presented for each questionnaire statement. The responses of SMP and SMA students to the environmental variable are summarized in Table 3.

Table 3. Distribution of Answers on the Environmental Variable at Each Educational Level

Indicator	Question Items	STS		TS		N		S		SS		Total of Respondents	Mean per Item	Mean per Indicator	Category
		F	%	F	%	F	%	F	%	F	%				
Knowledge	EL1	-	-	1	1	5	3	61	31	31	66	195	4.62	4.19	High
	EL2	-	-	4	2	107	55	65	33	33	10	195	3.51		
	EL3	-	-	-	-	33	17	96	49	49	34	195	4.17		
	EL4	2	1	-	-	19	10	85	44	44	46	195	4.33		
	EL5	3	2	12	6	16	8	56	29	29	55	195	4.30		
Hope	EL6	1	1	3	2	11	6	74	38	38	54	195	4.44	4.34	High
	EL7	-	-	6	3	62	32	82	42	42	23	195	4		
	EL8	-	-	2	1	32	17	91	47	47	36	195	4		
	EL9	-	-	2	1	22	11	78	40	40	47	195	5		

Indicator	Question Items	STS		TS		N		S		SS		Total of Respondents	Mean per Item	Mean per Indicator	Category
		F	%	F	%	F	%	F	%	F	%				
	EL10	-	-	-	-	4	2	58	30	30	68	195	5		
	EL11	-	-	1	1	20	10	88	45	45	44	195	4		
	EL12	-	-	1	1	19	10	76	39	39	51	195	4.4		
Cognitive	EL13	6	3	10	5	42	22	72	37	37	33	195	3.92	3.95	High
	EL14	5	3	5	3	55	28	79	41	41	26	195	3.85		
	EL15	-	-	8	4	52	27	84	43	43	26	195	3.91		
	EL16	-	-	3	2	43	22	84	43	43	33	195	4.08		
	EL17	-	-	4	2	33	17	106	54	54	27	195	4.06		
	EL18	2	1	10	5	85	44	71	36	36	14	195	3.57		
	EL19	-	-	2	1	44	23	83	43	43	34	195	4.09		
	EL20	1	1	4	2	39	20	79	41	41	37	195	4.11		
Behavior	EL21	-	-	1	1	8	4	38	19	19	76	195	4.71	4.44	High
	EL22	-	-	-	-	2	1	28	14	14	85	195	4.84		
	EL23	-	-	-	-	16	8	50	26	26	66	195	4.58		
	EL24	-	-	6	3	50	26	56	29	29	43	195	4.11		
	EL25	1	1	4	2	41	21	72	37	37	39	195	4.13		
	EL26	-	-	-	-	27	14	83	43	43	44	195	4.30		
Mean of Variabel Value														**4.23**	

Source: Processed Data, 2024

Indicator	Code	Question
Knowledge	EL1	The Sun is the primary source of energy for all life on the Earth's surface.
	EL2	The biosphere refers to all living organisms and the non-living components of their environment.
	EL3	Precipitation in the form of rain, ice, or snow occurs after surface water is heated and evaporates into the atmosphere, then cools and condenses back into liquid in the clouds.
	EL4	Worms, bacteria, and fungi play an important role in recycling the remains of dead organisms.
	EL5	Petroleum and coal are fossil fuels and are non-renewable resources.

Hope	EL6	I believe that people, working together, will be able to solve most environmental problems.
	EL7	I believe that scientists will find solutions to environmental problems.
	EL8	As a religious person, I am aware that environmental problems are my concern.
	EL9	Because everyone can learn from their own and others' mistakes, our positive actions can have a positive impact on the environment (religion teaches repentance).
	EL10	We can solve environmental problems if everyone works together, because religion encourages people to help one another in doing good.
	EL11	Environmental problems are very complex, but we must always believe that we can overcome them, because religion teaches humans to be optimistic.
	EL12	Because my religion teaches these principles, I realize that there are many things I can do to help address environmental problems.
Cognitive	EL13	The human population is growing rapidly in a geometric pattern, while agricultural land is being degraded, forests are shrinking, species are becoming endangered, clean water supplies are declining, fisheries are decreasing, and pollution is threatening human health.
	EL14	Air pollution is defined as the presence of contaminants (in the form of one or more physical, chemical, or biological substances) in the open air (atmosphere) at such concentrations and durations that they cause disturbance, danger, or potential harm to human, animal, or plant health, or to other objects, and interfere with comfort and aesthetics.
	EL15	Global warming is the gradual increase in the Earth's surface temperature, partly caused by pollutant emissions. These pollutants accumulate in the atmosphere, forming a thick layer that contributes to global warming and the greenhouse effect. Climate change caused by global warming disrupts the lives of living beings on a global scale.
	EL16	The conservation of biological natural resources and their ecosystems aims to preserve these resources and ecological balance so that they can better support efforts to improve community welfare and human quality of life. This goal is a responsibility and obligation of both the government and society.
	EL17	The environmental conditions of nature conservation areas should be utilized while maintaining their ecological functions. The use of plant and wildlife species must consider the potential, carrying capacity, and biodiversity of these species.
	EL18	Rapid population growth affects the availability of land, which is insufficient to meet people's welfare needs. The total area of land is fixed and cannot be expanded to accommodate the increasing burden on the environment. The carrying capacity of nature is becoming increasingly unbalanced with the accelerating demands of human needs. On this

		basis, environmental exploitation is carried out systematically in various ways and under various justifications.
	EL19	The ultimate goal of quality sustainable development is to provide people with a decent standard of living in this world and in the hereafter, including adequate clothing, food, and housing; proper education for their children; good health (including environmental health); necessary employment opportunities; safety and political freedom; freedom from fear and violence; and freedom to exercise their rights as citizens. This level of welfare is pursued while preserving the natural environment and ensuring the availability of necessary resources.
	EL20	Technological solutions, political regulations, or financial development alone cannot achieve sustainable development. High-quality education and learning are urgently needed for sustainable development at all levels of education and within society.
Behavior	EL21	I turn off the lights when leaving a room.
	EL22	I turn off the water when it is not in use.
	EL23	I close the refrigerator door immediately after taking something out, or if I have not yet decided what to take.
	EL24	At home, I recycle waste.
	EL25	At school/at the pesantren and/or in the community, I take part in activities related to natural resource conservation.
	EL26	I learn skills that can help many people and prefer skills that are environmentally friendly.

The results in Table 3 show that most respondents agreed or strongly agreed with each statement in the environmental variable. This indicates that their perception of the influence of environmental aspects on efforts to develop an environmentally concerned Islamic generation is high, with mean scores above 3.50 for every statement and every indicator within the environmental variable. The highest mean scores are found in the hope and behavior indicators, both with mean values above 4.

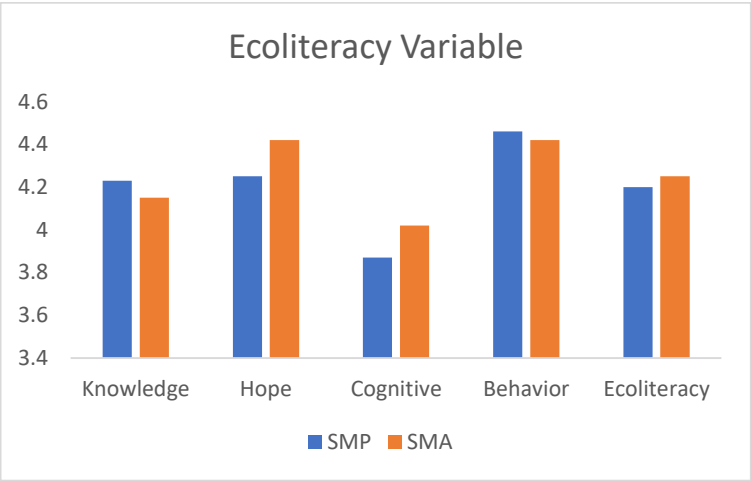

Figure 2. Ecoliteracy Variables

For the knowledge indicator, the items EL1, EL3, EL4, and EL5 have high mean scores (greater than 4), while EL2 falls into the medium category with a mean score of 3.51. This suggests that

respondents tend to understand basic knowledge related to natural phenomena around them and choose a neutral response when they are unsure which answer is correct.

The hope indicator also records a high mean value, with most respondents selecting agree or strongly agree. This reflects a strong sense of concern and optimism regarding the resolution of environmental problems in their surroundings, grounded in religious principles that emphasize each person's positive role and the importance of cooperation. Nevertheless, around 32% of respondents chose a neutral response to EL7, which concerns the ability of scientists to find solutions to environmental issues.

Furthermore, the cognitive indicator also shows a high mean score. Respondents are aware of the problems arising from rapid population growth that are not aligned with current conditions, such as shrinking agricultural land, deforestation, species extinction, diminishing clean water supplies, declining fisheries, and pollution that endangers human health. Observational data likewise indicate that respondents understand the need for solutions that can realize the goals of quality sustainable development aimed at providing a decent standard of living. However, 44% of respondents chose a neutral response to item EL18 when confronted with the idea of systematically exploiting the environment in various ways and under various justifications to achieve these goals.

Respondents' understanding of environmental conservation is supported by their habits, as reflected in the behavior indicator, which shows high mean scores (greater than 4) for all items. Respondents are also involved in conservation activities within their communities and are willing to learn environmentally friendly skills that can benefit more people.

Distribution of Respondents' Answers on the Ecotheology Variable

The distribution of respondents' answers is presented for each item in the ecotheology variable. The responses of SMP and SMA students to the ecotheology variable are summarized in Table 4.

Table 4. Distribution of Respondents' Answers on the Ecotheology at Each Educational Level

Indikator	Question Items	STS		TS		N		S		SS		Total of Respondents	Mean per Item	Mean per Indicator	Category
		F	%	F	%	F	%	F	%	F	%				
Tawhid	ET1	2	1	-	-	20	10	55	28	118	61	195	4.47	4.22	High
	ET2	-	-	2	1	23	12	89	46	81	42	195	4.28		
	ET3	45	23	32	16	13	7	37	19	68	35	195	3.26		
	ET4	-	-	-	-	5	3	50	26	140	72	195	4.69		
	ET5	-	-	-	-	22	11	76	39	97	50	195	4.38		
Khalifah	ET6	24	12	56	29	44	23	47	24	24	12	195	2.95	3.61	Medium
	ET7	4	2	5	3	10	5	64	33	112	57	195	4.41		
	ET8	45	23	19	10	14	7	35	18	82	42	195	3.46		
	ET9	27	14	46	24	63	32	39	20	20	10	195	2.89		
	ET10	24	12	22	11	33	17	41	21	75	38	195	3.62		
	ET11	13	7	5	3	12	6	44	23	121	62	195	4.31		
Khalaq	ET12	-	-	2	1	16	8	66	34	111	57	195	4.47	3.75	High
	ET13	-	-	1	1	26	13	91	47	77	39	195	4.25		

Indikator	Question Items	STS		TS		N		S		SS		Total of Respondents	Mean per Item	Mean per Indicator	Category
		F	%	F	%	F	%	F	%	F	%				
	ET14	36	18	23	12	14	7	35	18	87	45	195	3.58		
	ET15	64	33	25	13	43	22	34	17	29	15	195	2.69		
Mizan	ET16	1	1	-	-	10	5	69	35	115	59	195	4.52	3.88	High
	ET17	4	2	5	3	20	10	81	42	85	44	195	4.22		
	ET18	38	19	10	5	10	5	40	21	97	50	195	3.76		
	ET19	13	7	29	15	95	49	37	19	21	11	195	3.12		
	ET20	1	1	7	4	74	38	63	32	50	26	195	3.79		
Mean Skor Variabel														**3.86**	

Source: Processed Data, 2025

Indicator	Code	Question
Tawhid	ET1	Springs must be protected because they are created by Allah, belong to Allah, and are sacred signs of Allah's greatness.
	ET2	I understand how nature functions and cycles, and this understanding strengthens my faith.
	ET3	Humans are not part of the ecosystem and therefore can live independently without depending on animals, plants, water, air, and soil.
	ET4	I am always amazed by natural and environmental phenomena, which remind me of Allah.
	ET5	I always affirm the existence of Allah when I see and am present in the natural environment.
Khalifa	ET6	Humans are Allah's vicegerents (khalifah) on Earth and therefore have full freedom and authority to use nature as they wish.
	ET7	Not littering is a form of human responsibility as khalifah on Earth.
	ET8	Clean living behavior has nothing to do with faith, because faith only concerns the relationship between humans and Allah.
	ET9	Humans are free to use water as they wish because nature can achieve its own balance in accordance with Allah's decree.
	ET10	Muslims are not obliged to restore degraded environments because that is the duty of the government (the state).
	ET11	All human deeds will be held to account before Allah in the Hereafter, so humans must always do good to all creatures, including animals, plants, water, soil, and air.
Khalaq	ET12	Everything in nature has the right to continue to exist, including animals, plants, water, soil, and air.

	ET13	Everything in nature created by Allah has potential goodness and beauty, although not all humans are aware of it.
	ET14	Water, air, and soil are not living beings, so humans do not need to take care of them.
	ET15	I believe that animals and plants that seem useless were created by Allah with real benefits for maintaining ecosystem balance.
Mizan	ET16	Concern for nature is as important as social concern for fellow human beings.
	ET17	Leaving lights on when they are not in use is a wasteful act (*mubadzir*) and therefore a sinful behavior.
	ET18	I do not care about floods or droughts because they do not occur where I live.
	ET19	In Islam, what is most important is the relationship with Allah (hablun minallah) and with other humans (*hablun minannaas*), while the relationship with nature (*hablun minal 'alam*) is a separate and different concept.
	ET20	Exploiting nature is a sin; therefore, environmental carrying capacity must be taken into account.

The results in Table 4 show that most respondents agreed or strongly agreed with each statement in the ecotheology variable. This indicates that their perception of the influence of ecotheology on efforts to develop an environmentally conscious Islamic generation is high, with mean scores above 3 for every statement and every indicator within the environmental perception construct. The highest average scores are found in the Tawhid indicator, with mean values above 4.

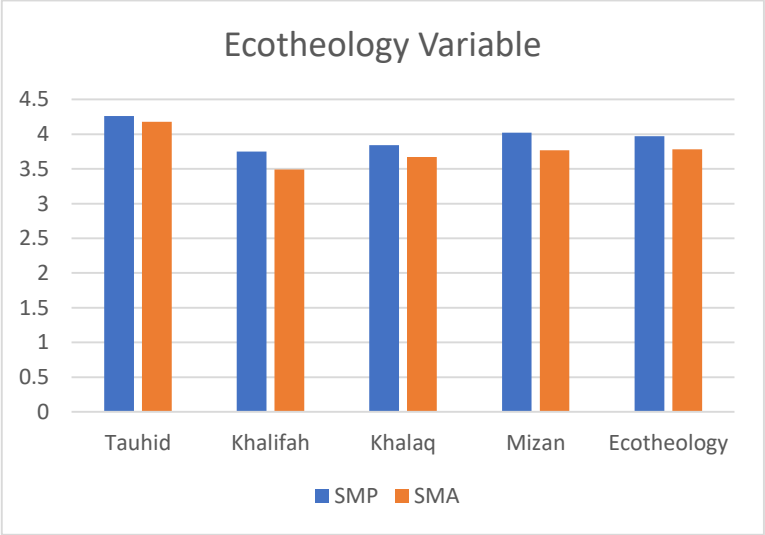

Figure 3. Ecotheology Variable

For the Tawhid indicator, items ET1 and ET4 have high mean scores (greater than 4), suggesting that respondents tend to care for nature because it reminds them of Allah's greatness. In contrast, item ET3 falls into the medium category (mean 3.26), with 23% of respondents choosing "strongly disagree" and 16% choosing "disagree." This pattern indicates that respondents generally understand that humans are part of the ecosystem and depend on animals, plants, water, air, and soil.

In the Khalifah indicator, the mean score is in the medium range (3.61). This is influenced by items ET6, ET8, and ET9, which also have medium mean scores, reflecting an understanding that although humans are khalifah on Earth, they may not exploit Allah's entrusted natural resources arbitrarily.

Meanwhile, items ET7, ET10, and ET11 have high mean scores, indicating that respondents feel responsible for protecting nature as khalifah who will ultimately be held accountable in the Hereafter.

The Khalaq indicator also shows a high mean value, which demonstrates respondents' awareness that everything created by Allah in nature has potential goodness and beauty in maintaining ecosystem balance. Observational data further suggest that respondents understand that water, air, and soil are entities that must be protected, even if not biologically "living" in a strict sense.

The Mizan indicator likewise records a high average score, signifying respondents' understanding of the need to care for nature, avoid wastefulness in using natural resources, and refrain from excessive exploitation. For items ET18 and ET19, responses tend to cluster around "disagree" and "strongly disagree," because these statements contradict respondents' understanding that concern for fellow humans and for nature are both important in Islam.

Influence of Ecotheology on Ecoliteracy

The relationship between ecotheology and environmental literacy through their respective indicators was analyzed using a SEM-PLS model to maximize the R-square value and to support Multiple Group Analysis (MGA). The overall model is illustrated in Figure 4, with the SMP model in Figure 5 and the SMA model in Figure 6.

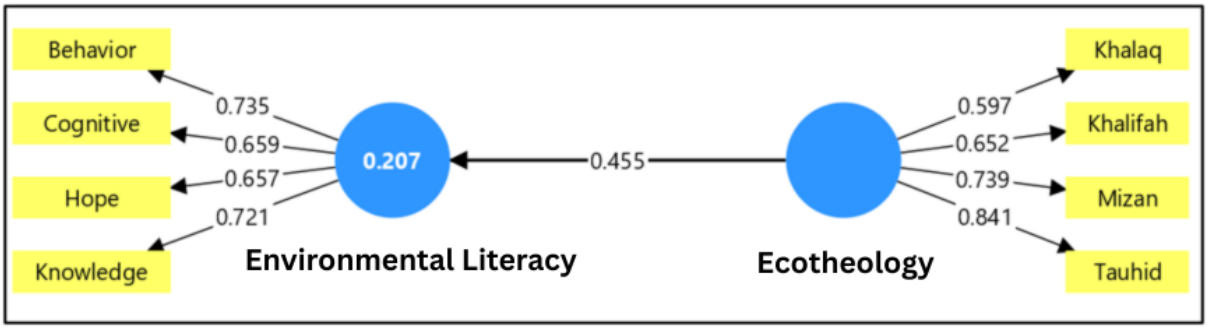

Figure 4. The Whole Model

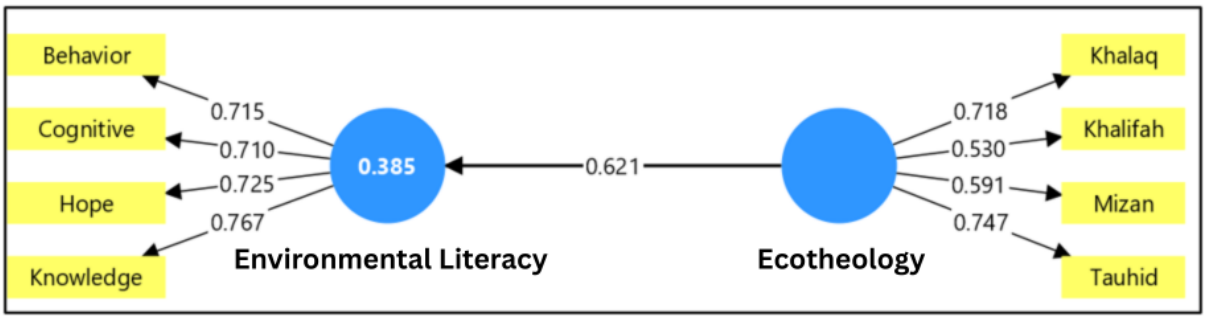

Figure 5. Junior High School (SMP) Model

Figure 6. Senior High School (SMA) Model

The outer model measurement employed four criteria: convergent validity, discriminant validity, composite reliability, and Cronbach's alpha. Convergent validity was examined using factor loadings (outer loadings) for each indicator and the AVE (Average Variance Extracted), which was required to be at least 0.50. Discriminant validity was assessed using the HTMT (Heterotrait–Monotrait Ratio) matrix (values below 0.90), the Fornell–Larcker criterion matrix, and the cross-loading matrix. The Fornell–Larcker and cross-loading analyses compared each indicator's loading on its own construct with its loadings on other constructs; lower values on other constructs would indicate acceptable discriminant validity, while higher cross-loadings would signal problems. Composite reliability (CR) and Cronbach's alpha (CA) were used to evaluate reliability, with CA values above 0.70 considered good, values between 0.60 and 0.70 still acceptable, and CR required to exceed 0.60.

Evaluation of the outer model—particularly discriminant validity and construct reliability—was conducted using the full sample of 195 respondents. Convergent validity was examined in three models (overall, SMP, and SMA), with the SMP and SMA models used to support interpretation of the convergent validity results in the overall model. The inner model evaluation was then carried out for the overall model as well as for the SMP and SMA models, focusing on path coefficients, significance levels, and explanatory power. The results of convergent validity and construct reliability analysis are presented in Table 5.

Table 5. Results of Convergent Validity and Construct Reliability Analysis

		LF MGA Model's		Convergent Validity Full Model		Reliability Full Model	
Latent Variable	Indicator	SMP	SMA	LF	AVE	CR	CA
Ecotheology	Khalaq	0.718	0.442	0.597	0.509	0.803	0.712
	Khalifah	0.530	0.694	0.652			
	Mizan	0.591	0.836	0.739			
	Tawhid	0.747	0.892	0.841			
Environmental Literacy	Behavior	0.715	0.730	0.735	0.482	0.787	0.650
	Cognitive	0.710	0.663	0.659			
	Hope	0.725	0.735	0.657			
	Knowledge	0.767	0.575	0.721			
Notes: Loading Factor (LF) ≥ 0.5 acceptable; CA >0.7 or 0.6<CA<0.7 still acceptable; CR >0.6; AVE ≥0.5 or 0.4<AVE<0.5 with CR >0.6 still acceptable							

Source: Processed Results on Smart PLS 4.1, 2025

Testing of convergent validity (Table 5) was carried out only on the full model, while the MGA model was used to interpret and compare factor loadings between the junior high (SMP) and senior high (SMA) groups and to help explain the loading values obtained in the full model. The analysis shows that all indicators in the full model have outer loading values greater than 0.50 and AVE values of at least 0.50 for the ecotheology variable. AVE values between 0.40 and 0.50 are still acceptable if the CR value exceeds 0.60, which indicates that the environment construct also meets the requirements for convergent validity.

The results further show that the lowest factor loading in the Ecotheology construct appears in the Khalaq indicator, most likely because SMA students tend to perceive that Khalaq does not adequately reflect the ecotheology construct, resulting in a relatively low loading value (0.442). In contrast, among SMP students, the Khalaq indicator shows a high level of fit with the ecotheology construct (0.718). For the Khalifah indicator, the lowest loading value is found in the SMP group (0.530), whereas in the SMA group it is higher (0.694). The highest loading values in the overall model are found in the Tawhid indicator (0.841), which also records the highest loadings in both the SMP and SMA models (0.747 and 0.892, respectively). The factor loadings of the environment literacy construct in the overall, SMP, and SMA models all meet the construct validity criterion (LF ≥ 0.50), with the highest loading in the overall model appearing in the Behavior indicator (0.735), which is also well reflected in both SMP and SMA models with loadings above 0.70.

The full-model discriminant validity results indicate that all indices fall within acceptable ranges (Table 6)

Table 6. Discriminant Validity Results

Measurement Index	Variable	Ecotheology	Environmental Literacy	Description
HTMT	Environmental Literacy	0.526		Good
Fornell Lacker	Ecotheology	0.713		Good
	Environmental Literacy	0.455	0.694	
Cross Loading	Khalaq	0.597	0.240	Good
	Khalifah	0.652	0.111	
	Mizan	0.739	0.262	
	Tawhid	0.841	0.482	
	Behavior	0.373	0.735	
	Cognitive	0.196	0.659	
	Hope	0.309	0.657	
	Knowledge	0.337	0.721	

Source: Processed Results on Smart PLS 4.1, 2025

Discriminant validity, which assesses the extent to which a construct is distinct from other constructs [32], was evaluated using cross-loadings, the Fornell–Larcker criterion, and HTMT [46]. The results show HTMT values below 0.90, cross-loadings for each indicator that are higher on their own constructs than on others, and AVE square roots that are greater than the inter-construct correlations, thus satisfying the Fornell–Larcker criterion. Therefore, the study concludes that the constructs meet the required discriminant validity.

In addition, each construct has Cronbach's alpha values between 0.60 and 0.70 and composite reliability (CR) values above 0.60, indicating that the latent constructs are accurate, consistent, and reliable.

The inner model (structural model) analysis, which relates to hypothesis testing among the research variables, was then conducted. Structural model evaluation used three criteria: testing hypotheses through t-statistics or p-values, examining R-square values, and comparing path coefficients between SMP and SMA groups. The results are presented in Table 7. Table 7 shows a significant positive relationship between Ecotheology and Environmental Literacy in the full model, as well as in the SMP and SMA models. The R-square value is categorized as low for the full model (20.7%) and for the SMA model (16%), but moderate for the SMP model (38.5%).

Table 7. Results of the Analysis of the Influence of Ecotheology on Environmental Literacy

Inner Model Evaluation		Skor
Full Model	Coeff	0.455
	p-value	0.000
	R-Square	0.207
Model SMP	Coeff	0.621
	p-value	0.000
	R-Square	0.385
Model SMA	Coeff	0.402
	p-value	0.000
	R-Square	0.161
SMP Model vs SMA Model	Coeff Difference	0.219
	p value	0.006
Note: p-value < 0.05 is significant		

Source: Processed Results on Smart PLS 4.1, 2025

The difference in path coefficients from Ecotheology to Environmental Literacy between the SMP model (0.621) and the SMA model (0.402) is statistically significant. This implies that, among the 90 SMP students, a higher understanding of ecotheology is strongly perceived to enhance their environmental literacy, whereas among the 105 SMA students, only part of the group perceives a positive relationship between ecotheological understanding and environmental literacy.

Discussion

The findings of this study show that ecotheology has a significant effect on students' environmental literacy. This indicates that religious values play an important role in shaping students' environmental knowledge, awareness, and behavior. In a related study [47], the integration of Islamic theology with ecological literacy is reported to significantly enhance students' environmental awareness and sense of responsibility. Ecotheology-based instruction increases students' appreciation of the importance of protecting the environment and influences their attitudes and behaviors toward environmental awareness [48-50]. Ecotheology functions as an intellectual framework that integrates religious values into ecological principles, thereby fostering a more comprehensive understanding of human obligations toward nature. By adopting a theological perspective that emphasizes sustainability, individuals not only grasp the empirical dimensions of environmental literacy but also assimilate spiritual aspects that cultivate ethical awareness to maintain ecological balance. Spiritual–ecological thought has been described as an ontological foundation for a way of life that is in harmony with nature and as a potential source of solutions to environmental crises, helping to minimize ecological damage and promote sustainable creation [51].

Ecotheology is thus shown to influence students' environmental literacy by encompassing cognitive aspects as well as increased awareness, attitudes, behavior, skills, and engagement that lead to environmentally responsible morals and ethics [52]. The results further reveal that the impact of ecotheology on environmental literacy is significantly stronger at the junior high (SMP) level than at the senior high (SMA) level. This phenomenon can be explained by the fact that SMP students are in early adolescence, a developmental phase in which affective dimensions and moral principles are still relatively malleable through spiritual and religious approaches. According to Piaget's theory, individuals aged 12 and above enter the formal operational stage, where their capacity for reasoning and critical thinking begins to develop [53,54]. At this stage, students tend to accept and emotionally internalize religious principles, making the application of ecotheology particularly effective for nurturing ecological awareness. Developmental psychology therefore plays a crucial role in understanding and supporting the physical, emotional, and social development of SMP students [55]. In contrast, late adolescents (approximately 16–18 years, typical of SMA students) have a more logical and critical cognitive style, and they no longer accept religious values purely on an emotional basis but instead process them through more complex reasoning [56]. Consequently, environmental education strategies grounded in ecotheology must be adjusted to the distinct psychological characteristics of each educational level to ensure optimal internalization of moral and ecological messages [57].

Within the ecotheology construct, the Tawhid component emerges as the strongest indicator, reflecting the central role of God's Oneness in shaping ecological consciousness. Ecotheology is closely related to human efforts to manage, care for, and preserve their environment as part of their responsibility before God [58]. In the environmental literacy construct, the behavioral dimension records the highest scores, indicating that the implementation of environmental values in concrete actions is strongly developed. The application of environmental theology is associated with healthy, environmentally responsible lifestyles that emphasize protection and stewardship of nature [59]. Ecological education aims to foster awareness, attitudes, and environmentally friendly behaviors in daily life [60,61], and in an Islamic context this approach can be integrated with Islamic ecopedagogy, which not only conveys ecological knowledge but also instills the spiritual understanding that caring for nature is an act of worship and part of human responsibility as khalīfah on Earth [62]. In this way, integrating ecotheology into pesantren education not only strengthens students' spirituality but also develops their reflective and ethical capacities in responding to global environmental issues. Empirical evidence supports this view by showing that environmental values significantly influence students' pro-environmental behavior [63].

These findings support the development of an environment-based pesantren curriculum as a practical manifestation of ecotheological values [64, 65, 41]. Targeted training for teachers, ustadz, and pesantren administrators is needed so that they are prepared to apply Islamic ecological principles in

teaching and institutional activities [66]. Religious values thus move beyond theoretical instruction and are embedded in everyday practices. This study aligns with the Eco-Pesantren program of Indonesia's Ministry of Environment and Forestry, which emphasizes the cultivation of a "green culture" in Islamic educational institutions. The program is expected to explore and elaborate Islamic concepts of the environment comprehensively and to increase Muslims' awareness of the importance of environmental stewardship [67, 68]. Such synergy can encourage the development of more contextual and sustainable models of Islamic environmental education. In addition, sustainable development and Islamic education are increasingly recognized as interconnected frameworks that support holistic human development [69]. The eco-pesantren model integrates environmental education into Islamic boarding schools by focusing on curriculum development and community involvement to strengthen environmental awareness [70].

Several limitations of this study must be acknowledged. First, the findings cannot be generalized broadly because of the limited sample size and the focus on a single pesantren. Differences in culture, curriculum, and students' backgrounds across institutions may influence environmental literacy levels and the extent to which ecotheology is applied. Second, the quantitative–descriptive methodology used in this study does not fully capture students' lived experiences, in-depth understandings, and motivational processes in linking religious teachings with environmental concern. The conceptual framework also does not yet incorporate potential mediating or moderating variables—such as sociocultural factors, institutional support, or the collective influence of the boarding school community—that may affect the strength of the relationship between ecotheology and environmental literacy. Consequently, the findings should be viewed as exploratory and as a foundation for more detailed future research. At the same time, these constraints create opportunities to refine methodological approaches, for example by using mixed-methods or longitudinal designs to track changes in ecological behavior over time.

Conclusion

This study demonstrates that the substantive integration of ecotheology enhances students' environmental literacy. The ecotheological approach translates religious principles—particularly those embodied in the Tawhid indicator—into ecological concepts, enabling students to understand environmental stewardship as an integral component of religious practice. Implementing ecotheology nurtures cognitive, affective, and behavioral dimensions that support sustained environmental care. The results underscore the need for Islamic education curricula to integrate ecotheological principles and for ongoing teacher training programs so that educators can apply these principles effectively in classroom and non-classroom settings. To ensure that moral and religious principles concerning the environment are well internalized, environmental learning approaches should be adapted to students' developmental stages. Such adaptation is crucial for deepening understanding of the relationship between ecotheology and environmental literacy.

Future research is encouraged to increase sample size, employ qualitative or mixed-method approaches, and incorporate mediating variables such as social or institutional support. It is also strongly recommended to expand ecotheology-based educational programs—such as eco-pesantren curricula—and to provide sustained professional development for teachers. In doing so, spiritual values will not remain purely theoretical but will be practiced in students' everyday lives, encouraging them to protect nature for ecological balance and a sustainable future.

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