

Education based on Sustainable Development in Islamic Boarding Schools to Address Climate Change

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Abstract: This study aims to explore the role of sustainable development-based education in Islamic boarding schools in addressing the challenges of climate change. Islamic boarding schools, as influential Islamic educational institutions, have the potential to shape students' behavior and awareness of the environment. This research focuses on how education in pesantren can be integrated with sustainable development principles to promote environmentally friendly attitudes and actions. The method used in this study is a mixed method that combines qualitative and quantitative approaches. Qualitatively, data were obtained through in-depth interviews with pesantren caregivers, ustadz, and santri, and non-participatory observation of sustainable practices in pesantren, such as waste management and greening programs. Quantitatively, a survey was conducted on a number of santri to measure their level of understanding and participation in environment-related activities. Data from these two methods were analyzed in triangulation to gain a holistic understanding of the implementation of sustainable development-based education in pesantren. The originality of this research lies in its rarely discussed focus, namely the integration of sustainable development education in Islamic boarding schools to address climate change issues. As a traditional educational institution, pesantren are often considered separate from global efforts related to sustainability. This research shows that pesantren can be effective agents of change in raising environmental awareness and facing the challenges of climate change through education based on Islamic values and sustainability principles.

Keywords: Sustainable Education, Boarding School, Climate Change, Environmental Awareness

Introduction

Global climate change is a pressing issue faced by many countries, including Indonesia. In general, climate change is characterized by an increase in global temperatures that leads to climate imbalances and extreme weather around the world (IPCC, 2021). The impacts of these changes include increased frequency of natural disasters, rising sea levels, and significant damage to ecosystems (NASA, 2021). A study from the Intergovernmental Panel on Climate Change (IPCC) states that an increase in global average temperature of 1.1°C compared to the pre-industrial era has resulted in an acceleration of disasters that are increasingly difficult to control (IPCC, 2021). Pesantren as an

Islamic educational institution that plays a major role in the lives of Indonesian people, has significant potential in educating the younger generation on climate change issues. Given that Indonesia is one of the countries vulnerable to the impacts of climate change due to its geographical condition as an archipelago, an education-based approach to instill environmental awareness is increasingly needed (Arini et al., 2024). Education based on sustainable development (ESD) is a suitable approach to be implemented in pesantren, because it can strengthen the understanding and behavior of santri in protecting the environment (Syamsuri et al., 2023).

Indonesia, as the largest archipelago in the world, is vulnerable to the impacts of climate

change (Evariste et al., 2018). Sea level rise has threatened small islands. While extreme rainfall intensity contributes to flooding, landslides and increasingly unpredictable weather (Nurhidayah et al., 2019). Recent research notes that over the past two decades, the frequency of natural disasters in Indonesia has continued to increase, with 81% caused by weather factors related to climate change (BNPB, 2022). Other findings also suggest that increasing greenhouse gas emissions and deforestation are exacerbating these impacts (Patrianti et al., 2020).

Seeing these problems, the educational approach instilled in santri can integrate Islamic values about nature conservation and the realization of their role in climate change mitigation (Gunawan et al., 2023). The importance of environmental and sustainable-based education in pesantren will shape the character and social awareness of people who are more concerned with environmental sustainability. Based on data from the Indonesian Ministry of Religious Affairs, Indonesia has around 26,975 pesantren spread across all provinces with more than 4 million students (Katadata, 2022). The potential arising from the large number of pesantren and santri can encourage the implementation of environment-based ESD programs in the pesantren curriculum (Nisa, 2019). Pesantren can encourage behavioral changes that support environmental sustainability, both through theoretical teaching and direct practice such as greening, waste management, and the use of renewable energy (Nurdiani & Muslim, 2022).

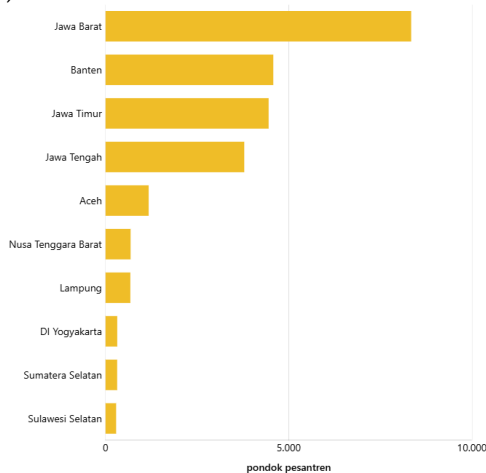


Figure 1. Number of Islamic Boarding Schools by Province in Indonesia (January 2022)

Sustainable development is a continuation mission of the MDGs developed by the United Nations that aims to sustain human welfare around the world (El Madaniya, 2024). Sustainable development is a process of change in which the exploitation of natural resources, the direction of investment, the orientation of technological development and institutional change are built to be harmoniously consistent with the needs of the future and the present (Alisjahbana & Murniningtyas, 2018). Meanwhile, sustainable education emphasizes the importance of teaching about sustainability, especially in protecting the environment and mitigating the effects of climate change. This education aims to shape behaviors that care for the environment through the integration of sustainability values in the curriculum and school activities (Goel et al., 2023). Including pesantren as traditional educational institutions have great potential to apply these principles in an Islamic setting, integrating religious teachings to strengthen responsibility for nature (Quddus, 2020; Safei & Himayaturohmah, 2023). Ecopesantren-based education introduced by the Ministry of Environment in 2011 is a concrete form of pesantren education to help form a generation that cares about the environment and is ready to play an active role in handling global environmental issues (Mandra & Ismail, 2022; Nurkhin et al., 2023).

The *sustainability-based* approach in pesantren education has a strong foundation in *sustainability theory* which emphasizes the importance of balance between economic, social, and environmental aspects to achieve long-term sustainability (Robert et al., 2005). One important element of this theory is the Triple Bottom Line. The concept was developed by John Elkington who integrated economic, social, and environmental aspects as the main pillars of sustainable development (Elkington, 1999). When applied in the context of pesantren, this theory supports the implementation of education that not only pays attention to religious and academic aspects, but also environmental sustainability. This becomes very relevant considering that pesantren can shape the behavior and views of santri in dealing with climate change through teaching

sustainability values in the pesantren curriculum (Chandra, 2020).

In addition, pesantren can become a strategic environmental education center, especially because the educational approach in pesantren is based on Islamic values that encourage concern for the environment. The implementation of the Islamic concept of *khalifah* on earth and human responsibility towards nature can be the basis for pesantren in adopting a curriculum that is more proactive towards environmental issues (Habibi & Tirmidzi, 2022). Sustainable development-based education in pesantren is in line with the Sustainable Development Goals (SDGs) agenda, especially goal number 13 on climate action, which focuses on addressing climate change and its impact on society (UNESCO, 2022).

Some previous research related to the topic of this research is explained by Sterling (2010), which suggests the importance of transformative learning in ESD, which aims to form a paradigm shift among students in understanding sustainability and climate change issues. Meanwhile, research by Tilbury (2011) focuses on the implementation of ESD in the context of informal education, including community-based programs designed to increase community involvement in environmental conservation. A more focused study was conducted by Rochmania (2022) who found that some pesantren in Indonesia have begun to implement environment-based programs to increase santri awareness of sustainability issues, such as tree planting and waste management. On the other hand, a sustainable approach to education should be transformative, emphasizing learning that engages students in concrete actions to achieve long-term impact. Then Mochizuki and Fadeeva (2010) highlighted the challenges in integrating ESD in educational institutions, especially related to the complexity of climate change as a multidimensional issue. However, Azra (2015) emphasized the potential of pesantren as faith-based educational institutions to internalize sustainability values through Islamic teachings that support environmental protection.

Based on the differences in previous studies, there is a research gap in terms of integration between the transformative approach in ESD and religious-based educational institutions such as

pesantren. In addition, there is still a lack of previous research related to evaluating the long-term impact of ESD in pesantren, especially climate change mitigation efforts in Indonesia. This research will attempt to fill the gap by developing a more structured and systematic sustainability-based approach in pesantren to address climate change.

Materials and Methods

Procedures

Type of Research

This research is a mixed method research, which is a combination of quantitative and qualitative research. This study was measured by one dependent variable, namely habit and two independent variables, namely knowledge and attitude. Quantitatively, a survey was conducted on a number of santri to measure their level of understanding and participation in environment-related activities. Qualitatively, data were obtained through in-depth interviews with pesantren caregivers, ustadz, and santri, as well as non-participatory observations of sustainable practices in pesantren, such as waste management and greening programs.

Research Subject

The subjects involved in this study were 100 respondents at boarding school students, both boarding schools at the MTs / SMP, MA / SMA, and university students in the Special Region of Yogyakarta. Tabel I menunjukkan distribusi sampel menurut variable jenis kelamin dan pendidikan santri. Table I shows the distribution of samples according to gender and education variables.

Table 1. Distribution of research samples

Variabel	Frekuensi	(%)
Gender		
Male	46	46
Female	54	54
Santri Education		
SD/MI	0	0
SMP/MTs	10	10
SMA/MA	18	18
Collage Student	76	76

Source: Researcher's Personal Document

Interviews were conducted with informants who were pesantren caregivers, ustadz, and

boarding school students who were directly involved in the research topic. Quantitative data was obtained through questionnaires to measure the effect of each independent variable on the dependent variable in the study and interviews were conducted to explore the role of boarding schools on research variables.

Data Collection Techniques

This research was conducted with several data collection techniques, namely questionnaires, observations, interviews, and documentation studies. From the results of the questionnaire, then processed and tabulated in accordance with the data categories which are then used as initial data to be explored through interviews, documentation studies and continued with a comprehensive validation and analysis process. Observation is carried out non-participatively, the researcher observes by not being directly involved in the location and context of the research (Rachmawati, 2017). Documentation aims to obtain information on sustainable practices in the pesantren, such as waste management and greening programs. Meanwhile, interviews were conducted in-depth and semi-structured by taking purposive sampling to obtain informant sources. Data from these two methods were analyzed in triangulation to gain a holistic understanding of the implementation of sustainable development-based education in pesantren.

Instrument

An e-questionnaire with (68 items) was developed to collect data from boarding school students from MTs/SMP, MA/SMA, and university students to answer three questions related to students' knowledge, attitudes, and habits towards sustainable development. The electronic questionnaire consists of three (3) scales with details of the first scale consisting of 20 items measuring santri's knowledge of sustainable development, the second scale consists of 14 items measuring santri's attitudes towards sustainable development, and the third scale includes 34 items measuring santri's habits about sustainable development.

The three scales use a five (5) point Likert scale from 1 to 5 with details of 1= "strongly disagree", 2 = "disagree", 3= "neutral", 4= "agree", and 5=

"strongly agree". Most of the questionnaire items were selected from the works of Meyer (2004) and Michalos et.al. (2012) in Al-Nabqi and Alshannag's research (2018) which were then adapted and modified to fit the context of Islamic boarding schools.

Data analysis

This research uses mixed methods that combine qualitative and quantitative approaches to gain a more comprehensive understanding of the topic under study. The qualitative approach through interviews helped the researcher understand the context and reasons underlying the behavior or perceptions of the individuals in this study. Thematic analysis is used to identify, analyze and report patterns (themes) in interview data (Luhmann, 2021). This process involved a deep understanding of the interview transcripts, coding the data, and grouping the codes into broader themes, which then became the basis for data interpretation. Meanwhile, a quantitative approach was used with multiple linear regression analysis using IBM SPSS 27 software to test the relationship and influence between several independent variables on the dependent variable. Multiple linear regression analysis allows researchers to measure the simultaneous effect of independent variables on the dependent variable, which is particularly useful in studies with many interacting variables (Murtagh & Heck, 2012).

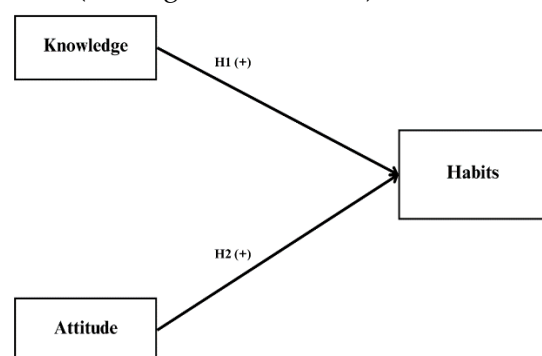


Figure 2. Framework of Thought

Results and Discussion

Result-1 (Statistik deskriptif)

Table 2. Descriptive statistics

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
X1	101	58,00	100,00	86,3762	9,86798
X2	101	41,00	70,00	58,4752	7,52409
Y	101	83,00	170,00	134,7723	20,69970

Based on table 2, it can be seen that the research sample is 101 which consists of independent variables, namely knowledge (X1) and attitude (X2) and the dependent variable of habits (Y). The minimum value of Y is 83 and the maximum is 170 with an average of 134.7723 and a standard deviation of 20.69970. Then X1 has an average value of 86.3762 with a standard deviation of 9.86798. The minimum value is 58 and the maximum is 100. Then variable X2 stores a minimum value of 41 and a maximum of 70 with an average of 58.4752 and a standard deviation of 7.52409.

Result-2 (Validity test)

Table 3. Validity test

Correlations					
		X1	X2	Y	
X1	Pearson Correlation	1	,749**	,647**	
	Sig. (2-tailed)		,000	,000	
	N	101	101	101	
X2	Pearson Correlation	,749**	1	,607**	
	Sig. (2-tailed)	,000		,000	
	N	101	101	101	
Y	Pearson Correlation	,647**	,607**	1	
	Sig. (2-tailed)	,000	,000		
	N	101	101	101	

** Correlation is significant at the 0.01 level (2-tailed).

Based on the table above, it can be seen that the significance value of each variable is less than 0.05. Then each variable meets the validity test or is said to be valid.

Result-3 (Reliability test)

Table 4. Reliability test

Reliability Statistics	
Cronbach's Alpha	N of Items
,962	68

Based on the table above, it can be seen that the Cronbach's Alpha value of each variable is more than 0.6. So each variable meets the reliability test or is said to be reliable.

Result-4 (Normality test)

Table 5. Normalitas Kolmogorov-Smirnov Test

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		101
Normal Parameters	Mean	,0000000
	Std. Deviation	15,30569595
	Most Extreme Differences	
	Absolute	,089
	Positive	,078
	Negative	-,089
Test Statistic		,089
Asymp. Sig. (2-tailed)		,065
Monte Carlo Sig. (2-tailed)		,045
	99% Confidence Interval	
	Lower Bound	,039
	Upper Bound	,050

Based on table 4 shows the value of Asymp. Sig. (2-tailed) of 0.065 which exceeds the significance value of 0.05. So it can be said that the data is normally distributed.

Result-5 (Multikoleniaritas Test)

Table 6. Multikoleniaritas test

Coefficients ^a			Collinearity Statistics	
Model			Tolerance	VIF
1	X1		,440	2,275
	X2		,440	2,275

Table 5 shows the results that the tolerance value of X1 is ,440 and VIF is 2.275. Because all tolerance values > 0.1000 and VIF < 10.00, there are no symptoms of multicollinearity.

Result-6 (Heteroskedastisitas Test)

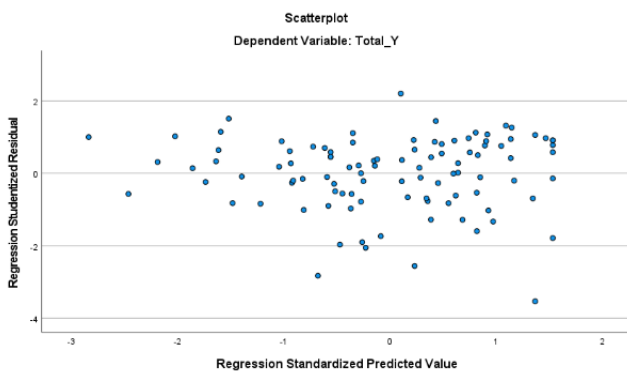


Figure 3. Heteroskedastisitas Scatterplot Test

Figure 1 shows the results of the heteroscedasticity test through the scatterplot. It can be seen that the distribution of points does not have a certain pattern such as gathering in the middle, narrowing or widening and vice versa, so there is no heteroscedasticity.

Result-7 (Autokorelasi Test)

Table 7. Autokorelasi Durbin Watson Test

Model Summary ^b					
Model	R	Squa re	Adjusted R Square	Std. Error of the Estimate	Durbin - Watson
1	,673 a	,453	,442	15,46109	1,815

Table 6 shows the results of the autocorrelation test using durbin-watson has a result of 1.815

which is between $dU < d < 4-dU$ ($1.7364 < 1.815 < 2.2636$). Then there is no autocorrelation.

Result-8 (T-test)

Table 8. T-test

Model	Unstandardized Coefficients B	Std. Error	Standardized Coefficients Beta	t	Sig.
1 (Const ant)	10,446	13,914		,751	,455
X1	,919	,236	,438	3,888	,000
X2	,769	,310	,280	2,481	,015

Based on table 7, it explains that variable X1 has an influence on Y with a significance value of 0.000. While the X2 variable also has an effect on Y with a significance value of 0.15.

Result-9 (F-test)

Table 9. F-test

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regres sion	19421,330	2	9710,66 5	40,6 23	,000 ^b
Resid ual	23426,433	98	239,045		
Total	42847,762	100			

Table 7 shows a significance value of 0.000 which explains the influence of the independent variable on the dependent variable as a whole.

Result-10 (Determination Coefficient Test)

Table 10. Determination Coefficient Test

Model Summary ^b					
Model	R	R Squa re	Adjusted R Square	Std. Error of the Estimate	Durbin - Watson
1	,673 ^a	,453	,442	15,46109	1,815

The test results show an R Square value of 0,453, indicating a high level of robustness worth 45.3% of the model in predicting changes in the next few periods.

Discussion

The Relationship between Knowledge of Sustainable Development and Santri Habits to Address Climate Change

In-depth knowledge of sustainable development gives students a better understanding of the impact of their actions on the environment. Thus encouraging santri to adopt more environmentally friendly behavior. According to Hwang et al. (2017), individuals who have good knowledge of environmental issues, such as climate change, tend to be more active in taking action to support sustainability. This research shows that strong knowledge of sustainability principles can raise awareness and influence the decisions santri make regarding their daily actions. In a pesantren environment, education that emphasizes environmental issues can be an effective tool in shaping santri behavior.

This is also in line with the research results taken from interviews with the management of Pesantren Ali Maksum Krapyak Yogyakarta. The concept of sustainable development in the pesantren is integrated through programs that utilize resources wisely and are environmentally friendly. One of them is the independent waste management program. The program is part of an effort to provide holistic education, combining religious values with environmental awareness. Pesantren mengajarkan santri untuk memilah dan mengolah sampah dengan benar. Organic waste is processed into compost for agriculture and greening around the pesantren, while non-organic waste such as plastic is collected for recycling or reuse. This process is not only an environmental activity, but also an educational tool to teach the importance of maintaining cleanliness and preserving nature as part of worship. Through this program, students learn about the principles of sustainable development, such as reducing waste, reusing items, and recycling. In this way, Pondok Pesantren Krapyak not only educates students academically and spiritually, but also instills awareness of social and environmental responsibility as part of practicing Islamic teachings.

In addition, other findings were also obtained from Pesantren Al-Imdad Yogyakarta, which in supporting santri knowledge related to sustainable

development was carried out directly with the practice of sorting waste. The practice of waste sorting in this pesantren is carried out every day, with a systematic schedule arrangement to involve all santri. This sorting process is divided into two main categories: organic and inorganic waste. Organic waste includes materials that can be decomposed naturally, such as food scraps and leaves, while inorganic waste includes plastic, paper, and materials that cannot be decomposed easily. Through the separation of these two types of waste, students learn about the concept of recycling and how waste can be reprocessed into products that have economic value. In terms of benefits, waste segregation not only helps reduce the amount of waste going to landfills, but also provides opportunities for students to learn about the economic value of waste. Organic waste generated can be composted for the pesantren's farm or garden, while inorganic waste can be sold to third parties who process it for recycling. Thus, santri not only contribute to efforts to keep the environment clean, but also understand the importance of managing resources efficiently and sustainably.

Pudjiastuti et al. (2021) stated that the implementation of environmental education programs in the pesantren curriculum succeeded in increasing students' awareness of the importance of maintaining environmental sustainability. Students involved in this program show improvement in pro-environmental habits, including participation in greening and waste management activities (Nugraha, 2020; Reza, 2022). In addition, the integration of religious values in sustainability education also plays an important role. Azra (2015) explains that Islamic teachings contain principles that encourage environmental preservation in line with sustainable development efforts.

Research by Fua et al. (2018) supports this view by showing that students receiving environmental and religious values-based education are more likely to engage in practices that support sustainability, such as efficient resource management and environmental conservation. Therefore, it is important for educational institutions including pesantren to continue to integrate sustainability education in their

curriculum, so that students can become active agents of change in society.

The Relationship between Sustainability Development Attitudes and Santri Habits to Address Climates Change

The relationship between attitudes towards sustainable development and santri habits in addressing climate change has a significant and positive influence. A positive attitude towards sustainability can increase students' awareness of the importance of the environment. Thus encouraging santri to adopt more pro-environmental habits. Research by Janmaimool and Khajohnmanee (2019) shows that individuals who have a positive attitude towards environmental issues tend to take actions to support sustainability, such as waste reduction and energy conservation. This indicates that santri who are educated to have a caring attitude towards the environment will be more actively involved in climate change mitigation efforts. Education in pesantren plays an important role in shaping santri attitudes towards sustainable development. According to research by Anshori and Pohl (2022), pesantren that integrate environmental education in their curriculum can help students develop a positive attitude towards sustainability. The study found that students involved in environmental education programs showed improvements in environmental awareness and environmentally friendly behaviors, such as the use of renewable energy and reduced plastic use. Through facilitating sustainability-focused learning experiences, pesantren can shape students' attitudes that support collective action to address climate change.

Other results shown through interviews with the management of Pesantren Ali Maksum Krapyak Yogyakarta explained that the formation of santri attitudes towards the environment was carried out through various practical and educational approaches, especially in the independent waste management program. This program plays an important role in instilling the values of caring for nature and teaching students to live more environmentally friendly lives. The program includes education and awareness. Santri

are taught about the importance of preserving nature as part of Islamic teachings that emphasize responsibility as khalifah on earth. Through religious studies associated with environmental issues, students are encouraged to understand that protecting nature is a form of worship and a form of love for His creation. Then the pesantren held routine activities such as sorting waste, making compost from organic waste, and managing the recycling of non-organic waste. This activity makes students accustomed to applying the principles of reduce, reuse, recycle in everyday life. In addition, Pesantren also limits the use of single-use plastics by encouraging the use of eco-friendly drinking bottles or shopping bags. In addition, santri are taught to save energy by getting used to turning off lights and electronic equipment when not in use and utilizing natural resources efficiently. Pesantren Ali Maksum Krapyak Yogyakarta also has an independent waste management program that has been running.

Furthermore, similar activities are also implemented by Pesantren Al-Imdad Yogyakarta, which involves students in processing waste as education in building attitudes according to the principles of sustainable development. Each santri is given a daily or weekly task to sort organic and inorganic waste. This activity not only serves as a practical means to manage waste, but also as an effective method to build awareness and environmental care attitudes in santri. By participating in waste management, students gain an in-depth understanding of the impact of waste on the environment and the benefits of responsible action. This practice also encourages students to understand that resources are not always available in abundance, so they must be used wisely and sustainably. This direct involvement forms positive habits in students that they can bring to the community after completing their education at the pesantren, strengthening the role of pesantren in fostering a generation that plays an active role in preserving the environment. In addition, waste management activities at Pesantren Al-Imdad Yogyakarta also introduce the concept of circular economy, where waste generated is not directly disposed of but rather reprocessed or reused for other more productive purposes.

Furthermore, the attitude of santri towards sustainable development can be influenced by the religious values taught in pesantren. As stated by Anggraini (2022), many teachings in Islam encourage environmental conservation and social responsibility. Research by Ilham & Noviarita (2024) also emphasizes that santri who receive education on environmental values and spirituality tend to be more motivated to engage in sustainability activities, such as greening and efficient resource management. So that the positive attitudes developed through faith-based and environmental education can lead to more responsible habits towards the environment. The relationship between attitudes towards sustainable development and santri habits in addressing climate change shows that effective education can produce a generation of santri more aware and responsible for the environment. This is critical in the collective effort to meet the increasingly urgent challenge of climate change.

Implementation of Sustainability Development in Eco-Pesantren

The implementation of sustainability development in Eco-Pesantren focuses on the application of sustainability principles in the pesantren environment that integrates environmental education, resource management, and environmentally friendly practices in the daily lives of students. In Eco-Pesantren, the concept of sustainability is not only part of the formal curriculum, but also applied in daily activities, which include waste management, greening, and the use of renewable energy (Bahri, 2018). Eco-Pesantren implements a waste management system that starts from sorting between organic and inorganic waste. Organic waste such as food waste and leaves are processed into compost which is used as fertilizer for the pesantren garden. The use of compost not only reduces waste but also enriches the soil naturally without pesticides or chemical fertilizers. Meanwhile, inorganic waste, especially plastic, is managed with a recycling system or sold to parties that can recycle it. This activity trains santri to be responsible for the waste they produce and helps them understand the importance of reducing plastic use (Herdiansyah, 2019).

Some Eco-Pesantren have started using renewable energy sources, such as solar panels, to support their daily electricity needs. The use of solar energy not only saves electricity costs, but also reduces dependence on fossil fuels that have a huge impact on the environment. The implementation of renewable energy provides practical examples to students on the use of environmentally friendly technologies as well as the economic and environmental benefits of renewable energy (Arifah, 2022). Education on sustainability in Eco-Pesantren is not only provided in the form of theory, but also in the form of practical activities and environmental campaigns (Anabarja & Mubah, 2021). Santri are encouraged to understand the concept of sustainability from a religious and ethical perspective, where protecting nature is seen as part of the human mandate. Activities such as socialization on reducing plastic waste, saving water and energy, and the importance of recycling become part of the learning program and extracurricular activities (Diavano, 2022).

Eco-Pesantren forms an attitude of environmental care in students which includes awareness of the importance of protecting nature and utilizing resources wisely. The hands-on experience they get at the pesantren teaches them to practice sustainability habits not only during their time at the pesantren, but also in their daily lives after they return to the community. This attitude development is important in shaping a generation that is more concerned about environmental sustainability and ready to contribute to climate change mitigation efforts. Examples of pesantren that apply this concept are Pesantren Ali Maksum Krapyak and Al-Imdad Yogyakarta. Pesantren Ali Maksum Krapyak has implemented various sustainability-based initiatives, focusing on environmental preservation through an integral approach. One of the main programs implemented is recycling-based waste management and waste reduction. In this pesantren, students are taught to sort waste into organic and inorganic. Sustainable development plans are integrated through programs that utilize resources wisely and are environmentally friendly. Some of these programs include independent waste management, the P5PRA program (project to

strengthen the profile of Pancasila rohmatah lil alamin students) a program from the government that is integrated with the Merdeka curriculum. As well as collaborating the precepts of Pancasila with religious values. In addition, there is a waste pioneer program where the madrasah student council conducts a school cleaning program and sorts waste. The pesantren cooperates with various parties such as the Panggungharjo village government, RMI Nahdlatul Ulama, Pesantren Emas, and Nahdlatul Ulama University who provide training on waste management. The key to the implementation of all these programs cannot be separated from the role of administrators and caregivers who are very important in guiding students so that habits that support sustainable development become an integral part of life.

Furthermore, the application of sustainable development-based education is also carried out by Pesantren Al-Imdad Yogyakarta. The waste management program at Al-Imdad involves students in daily waste sorting activities, where they learn to separate organic and inorganic waste. Organic waste is processed into compost which is used for the pesantren's garden, while inorganic waste, such as plastic, is collected and recycled or channeled for further processing. In addition to waste sorting, Pesantren Al-Imdad also has a greening program that involves students in planting trees around the pesantren area. The program not only aims to improve air quality and increase vegetation in the neighborhood. But also to give students an understanding of the importance of trees in maintaining the balance of the ecosystem. This reforestation activity supports students to play an active role in reducing the impact of climate change by absorbing carbon dioxide through trees.

Departing from the two pesantren case studies, there are great opportunities in implementing sustainable development through education. So that it can overcome the climate change that has occurred so far. Through the integration of sustainability concepts in educational activities and daily life, pesantren can create a direct impact on the environment while forming a generation that is more caring and responsible for the environment.

Conclusions

This research shows that sustainable development-based education (ESD) in pesantren can significantly shape the attitudes and behaviors of santri who are more concerned about the environment and responsive to climate change. Through the integration of sustainability values in the curriculum and practical programs such as waste management and reforestation, santri not only gain a deep understanding but are also actively involved in environmentally friendly practices. The results indicate a positive relationship between santri's knowledge and attitudes towards sustainability and their pro-environmental habits. The pesantren serves as a center for environmental education that links Islamic values with the responsibility of preserving nature. Thus, the implementation of ESD in pesantren has the potential to form a generation of santri who have a strong religious understanding as well as high social and environmental awareness, and make a real contribution in dealing with the impacts of climate change.

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