JPPIPA 11(2) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

The Potency and Urgency of Implementing Green Education in Sumenep Madura

Helliyatul Matlubah[1*], Herowati[1], Sindi Arista Rahman[2], Rizal Andi Sya'bana[3]

[1] Department of Science Education, Faculty of Teacher Training and Education, Universitas Wiraraja, Sumenep, Indonesia.
[2] Department of Agribusiness, Faculty of Agriculture, Universitas Wiraraja, Sumenep, Indonesia.
[3] Department of Post-Harvest Technology, Faculty of Agriculture, Universitas Wiraraja, Sumenep, Indonesia.

Received: October 08, 2024
Revised: December 17, 2024
Accepted: February 25, 2025
Published: February 28, 2025

Corresponding Author:
Helliyatul Matlubah
helliyatul@wiraraja.ac.id

DOI: 10.29303/jppipa.v11i2.10080

© 2025 The Authors. This open access article is distributed under a (CC-BY License)

Abstract: The environmental problems in Sumenep are concerning since the establishment of the Suramadu Bridge. These problems include the expansion of the extractive industry in Sumenep causing natural resource assets to shift ownership as well as threats from the mining sector which is causing an environmental crisis. The education sector should be at the forefront of educating the younger generation to face these environmental problems. One of the efforts in the education sector is through the implementation of green education in Sumenep in both formal and non-formal institutions. More comprehensive research regarding the importance of green education, especially in the Sumenep area, is necessary. This research aims to examine how formal and non-formal schools organize their learning starting from systems, curriculum, teaching materials and methods in relation to environmental issues. This research employed a descriptive-qualitative approach with a case-study design at three schools in Sumenep, namely MAN Sumenep, SMA 3 Annuqayah and KKAA-Nature School Community. The data collection methods included the questionnaire and interview. The findings show that the three-types of schools implemented green education with various systems, curricula, teaching materials and methods.

Keywords: Green education; Adiwiyata; Nature School; Environmental education; Green school.

Introduction

The environmental problems in Sumenep are increasingly massive. It was started once the establishment of the Suramadu Bridge on 10th June 2009. According to Keputusan Presiden Number 79 on 27th October 2003, the construction of the Surabaya-Madura Bridge is an effort to develop industrial areas, housing and various other sectors in the Surabaya and Madura regions. The construction of the Suramadu Bridge aims to increase the economy pace in the Madura region, including Sumenep (Wiprapto, 2015) so that the expansion of the extractive industry in the region develops rapidly. One impact caused by industrial expansion is the ownership of natural resource assets shifts. From what was initially collective, owned by the state, it became private ownership of capital owners. Since 2013, some coastal areas and rice fields in Sumenep have been privatized by capital owners and they are now turning into industrial concrete, starting from the oil and gas sector, rocks, shrimp ponds, saltworks, to housing and hotels.

In the midst of the environmental crisis in Sumenep, the education sector should be the frontliners to be involved in facing such environmental problems. It is important to develop environmental literacy skills for the younger generation in schools, especially in Sumenep, to deal with those issues (Safitri et al., 2024).

How to Cite:
Matlubah, H., Herowati, Rahman, S. A., & Sya'bana, R. A. (2025). The Potency and Urgency of Implementing Green Education in Sumenep Madura. *Jurnal Penelitian Pendidikan IPA*, *11*(2), 365–374. https://doi.org/10.29303/jppipa.v11i2.10080

This can be achieved through the Green Education program. Green education is an educational model that integrates the natural environment as a learning source for students with the aim that the young generation can be proactive and adaptive in responding to environmental problems and emphasizes the principles of independence, responsibility, courage and empathy towards the environment (Karmilasari et al., 2020). This term is often interchangeably used with green school, eco school, green learning, and education for sustainable development. These terms are oriented towards developing the character of students so that they are more sensitive to environmental problems (Nizaar, 2022).

Green school is known both in formal and non-formal education. The government launched a green school program in formal education (primary and secondary schools) called the Adiwiyata School. This program aims to encourage environmentally friendly school communities throughout the country (One Planet Network, 2015). The Ministry of Environment and Forestry (KLHK) (2023) has awarded national Adiwiyata certificates to 551 schools, where 85 schools are in East Java and one is in Sumenep, namely MAN Sumenep (the Center for Environmental and Forestry Generation Development or PPGLHK, 2023). However, due to this prestigious award, several schools that take part in this program tend to only aim to improve their school rankings (Parker & Prabawa-Sear, 2019). On the other hand, there is also another green school that is campaigning for zero plastic in the process of providing education, namely SMA 3 Annuqayah. This school has a waste bank managed by students as the members of the Pemulung Sampah Gaul (PSG) community initiated by the caretakers of the Annuqayah Islamic Boarding School (Mongaboy, 2019). This school seeks to instill a spirit of integrating environmental issues into the school.

In non-formal education, green schools are implemented as an alternative education called Sekolah Alam or nature-based schools. One in Sumenep that focuses on ecological problems is KSA (Komunitas Sekolah Alam) founded by the Annuqayah Islamic Boarding School Community Service Bureau (BPMPPA) in 2014. This school is called the Assalam Annuqayah Conservation Garden (KKAA) located in the Prancak Village, Pasongsongan. It began operating as an Assalam Play-Learning Community with a Natural School concept since 2019 (BPM-PPA,2021). The target is young children who come from the local area, namely Prancak Village.

Prior studies on green education were not specific to Sumenep but in several regions in Indonesia such as Bali, some of which were even limited to literature studies (Adnyana et al., 2023; Adnyana & Sudaryati, 2022; Huda & Utami, 2023; Nizaar, 2022). Research on green education conducted in China (Li et al., 2024) shows that environmentally friendly education can reduce and even overcome the negative impacts caused by the exploitation of natural resources. Another study (Meng et al., 2024) also discusses the efforts of higher education institutions in realizing a green campus. It is also supported by the study Adnyana et al. (2023) that there are several opportunities to implement green education in Indonesia, including dealing with environmental problems, introducing the concept of sustainability and educating individuals to have environmental awareness and concern. Therefore, it is important to study green education in this research because it includes formal and non-formal schools. Basically, both educational models have the same spirit, that is how education responds to environmental issues. Thus, this research aims to explore formal and non-formal schools organize their learning starting from their systems, curriculum, teaching materials, and teaching methods in relation to environmental issues. In the end, the results of this research will be the basis for why green education in Sumenep is necessary and important to implement. So that teaching materials, models, curricula and green education systems can ultimately be designed and adapted to a wider educational environment.

Method

This research employed a qualitative-descriptive method with a case study design. The samples included formal and non-formal schools in Sumenep that are involved with environmental issues, namely MAN Sumenep, SMA 3 Annuqayah and Assalam Annuqayah Conservation Gardens (KKAA)-Nature School Community (KSA). The research team has distributed questionnaires to the three school samples. Questionnaires were given to teachers and students involved in environmental-based activities to answer the research question. Then, data were collected through semi-structured interviews with school principals and teacher representatives to obtain an in-depth study of how formal and non-formal schools organize their learning starting from systems, teaching materials, curriculum and teaching methods related to environmental issues.

The research method is descriptive qualitative with a case study design using an interpretivist paradigm. The collection method included three stages, namely a sampling strategy using purposive sampling, filling out a questionnaire and semi-structured interviews. The details of each stage include 1) participant sampling strategy. where the researcher determined school

samples to be studied based on previously established criteria. These criteria include a) a formal or non-formal school located in Sumenep Regency, Madura, b) the school focuses on environmental issues, for example an Adiwiyata school, an environmentally based school or an alternative school such as a natural school. In this research, there were three schools that met these requirements, namely MAN Sumenep (National Adiwiyata School), SMA 3 Annuqayah (environment-based school) and the Assalam Annuqayah Conservation Garden (KKAA) Community School of Nature. 2) Filling out the questionnaire is when questionnaires were distributed and filled out by teachers who are involved in environmental-based activities at school. The questionnaire sample was determined based on the number of teachers involved from each school. MAN Sumenep was represented by a minimum of 10 teachers, SMA 3 Annuqayah was represented by a minimum of 10 teachers, and KSA Assalam was represented by a minimum of 5 teachers. The survey consists of 22 statements to which teachers must respond on a 1-4 Likert scale (strongly agree=4, agree=3, disagree=2, and strongly disagree=1). The survey results were then calculated the percentage for each aspect of the statement to obtain the data as presented in Table 1. 3) Semi-structured interviews were carried out with school leaders such as the Principal or headmaster, as well as two teacher representatives each. After data collection was conducted, the next process is data analysis techniques using thematic analysis. Then, the main themes were obtained such as school systems, curriculum, learning materials, and teaching methods used by the school samples.

Result and Discussion

Based on the results of surveys and interviews with school principals and teachers from the three sample schools, four main characteristics of schools implementing green education in Sumenep, Madura were obtained. These four aspects include an environment-based school system, environment-based curriculum, materials and teachers' teaching methods integrated with environmental issues. The teacher survey results from the three school models are presented in Table 1.

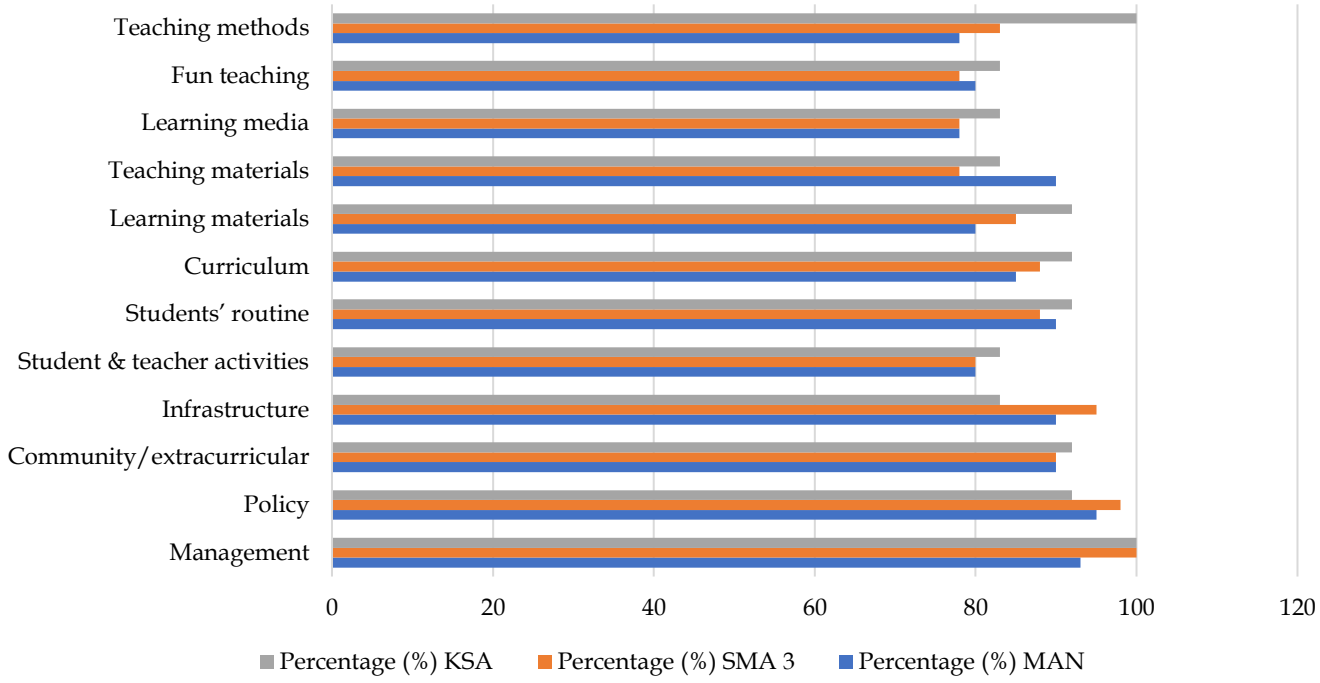

Figure 1. The Results of Teacher Survey from Three Schools

Environment-based school system

The findings show that one main characteristic of schools that implement green education starts from an environment-based school system. The system includes several indicators namely environment-based school policies and management, the existence of environment-based school programs like environment-based communities or school extracurricular programs, environment-based activities for teachers, students and school stakeholders, as well as supporting infrastructure. Based on the survey results, it shows that almost all respondents to this research believed that the management of the three schools was environmentally based. This management is also supported by policies

implemented in schools which are also environmentally based indicated by more than 90% of teacher responses from the three schools. As formal schools, MAN Sumenep and SMA 3 Annuqayah have almost the same policies, namely reducing the use of plastic in the school environment. The MAN Sumenep as an Adiwiyata school ensures that the school community minimizes the presence of non-organic waste, especially plastic. Likewise, SMA 3 Annuqayah also has the motto "towards zero plastic". One of the policies implemented at these two schools is Galonisasi. The Principal of MAN Sumenep said that "...in order to reduce or eliminate waste. Hence, there are Galonisasi rules, so in class we use gallons and children bring their tumblers." Based on a statement from one of the teachers, Ms. U, it turns out that this program is also being implemented at SMA 3 Annuqayah. Even, the school canteen is no longer allowed to sell bottled mineral water and fines are being imposed for students who violate it. This is in line with the research conducted by Anditha (2018) that Galonisasi is one of suggested programs to embed environmental awareness toward students.

Besides, there is also a Waste Bank program which is managed by students from both schools. A Waste Bank Program that has been conducted in MAN Sumenep and SMA 3 Annuqayah has also been implemented by other schools as an effort to instill character education and knowledge of waste management (Masirun et al., 2023; Wina Maryuni, 2024). If MAN Sumenep has Adiwiyata Team who is active in socializing and controlling the implementation of school environment-based programs, then SMA 3 Annuqayah has a community called PSG (Pemulung Sampah Gaul). Both teams have almost the same duties, such as to socialize policies related to protecting the environment, managing the Waste Bank starting from collecting, counting and distributing waste from each class, to supervising the implementation of the Galonisasi program. In order to enforce environment-based rules in schools, Adiwiyata Team then had a Patroli Lingkungan for every class, while at PSG, they formed a Srikandi Lingkungan (called Srikandi because SMA 3 Annuqayah only consists of female students).

The difference between the two formal schools' systems lies in the initial motivation and objectives for implementing environment-based programs. The headmaster of MAN Sumenep explained that implementing an environmentally based system was an effort to "create clean, healthy and shady schools". He also did not deny that "every effort also needs recognition, so these activities are linked to the relevant institution, namely DLH (Dinas Lingkungan Hidup) so that MAN Sumenep received an award as a national adiwiyata school. Meanwhile, SMA 3 Annuqayah implements an environment-based system initiated by its previous headmaster who has a passion and concentration in the environmental sector. Inspired by a conference on the environment, it was then applied in schools by forming a PSG community. The new principal of SMA 3 Annuqayah said that one of the school's visions is to build a school identity program so that the profile of graduates has skills, especially in the field of environment and social projects. Therefore, the program implemented by PSG does not only focus on reducing plastic waste, but also on how to manage organic waste to be used as organic fertilizer and preserving local food.

KSA Assalam as an alternative school also has an environment-based school system which is very close to nature. Judging from its name, this school has the concept of a school in nature. KSA Assalam was established in 2014 and is located in the Assalam Conservation Garden belonging to the Annuqayah Islamic Boarding School with an area of 15 hectares. The conservation garden is under the BPM (Community Service Bureau) Annuqayah. The location is in the middle of the forest in Prancak Village, Sumenep with the concept of learning directly from nature. As stated by the principal of KSA Assalam, the initiation of establishing this nature school was to bring students closer to the natural surroundings and provide a different learning atmosphere from schools in general. One mission carried out by the founder as well as director of Assalam before he passed away was "in the future, how can this generation care for its own land by introducing them to the natural surroundings. We hoped that the children will have more concern for caring for plants, nature and the surrounding environment." Besides, the main difference between the learning system at KSA Assalam and other formal schools based on information from the school principal is that children are free to choose what subject matter they are interested in. They are directly involved in protecting nature, starting from studying the types and benefits of surrounding trees, to planting and even caring for trees in the surrounding environment. Even though their age range is still elementary school, they have been taught about soil texture, the agricultural potential of the area, and how to preserve nature and the culture in their village.

Environment-based curriculum

The second characteristic is an environment-based curriculum. The curriculum refers to the definition contained in Undang-undang no. 20 of 2003 concerning the National Education System, namely "a set of plans and arrangements regarding objectives, content and learning materials as well as methods used as guidelines for implementing learning activities to achieve certain educational goals". The main curriculum used by the

two formal schools continues to follow the standard curriculum. The headmaster and MAN Sumenep teachers agreed that the school uses the Merdeka curriculum but is integrated with environmental education. Even though there is no a separate subject about PLH (Environmental Education), teachers try to see how other subject matter can be integrated with environmental issues. For example, Ms. N, the Mathematics teacher at this school teaches Mathematics concepts and relates them to the environment. Ms. N relates the material of the linear equation system to the importance of protecting trees because one tree can produce a certain percentage of oxygen for the needs of living things. Also, Mr. J, as a PJOK (Physical Education, Sports and Health) teacher and coordinator of the school's adiwiyata team, also confirmed that he also linked environmental material in his learning. For example, when Mr. J teaches PJOK outdoor, then students are asked to pick trash for approximately 5 minutes and collect the rubbish.

According to Ms. U that SMA 3 Annuqayah still applies Curriculum 13 in general, but PLH is added as a standalone subject for class X. Ms. A, as the PLH subject teacher, explained that PLH had been included by the previous Principal as a subject since 2014. PLH is mandatory in the school for several reasons, including in order to continue Annuqayah's vision which is related to protecting the environment and the history of SMA 3 Annuqayah which has an active environmental care community, namely PSG. Moreover, it was also stated that one of the reasons was because they saw environmental damage which was quite worrying so that the PLH curriculum could educate students to be more sensitive and involve in protecting and preserving the environment. Ms. A also added that PLH does not only cover environmental aspects but is also related to "economic, social, cultural and political" aspects. Even Ms. U, as a Geography teacher at the school, feels that when teaching Geography, she always focuses on environmental material, especially when explaining nature, the earth, the contents of the earth, relief, water hydrology and so on. Ms. A also shows a detailed description of PLH at the school (Figure 1).

Figure 1. PLH Curriculum at SMA 3 Annuqayah (resource: researchers' documentation)

The PLH, which was designed by the previous principal of SMA 3 Annuqayah, is a clipping of writings collection from various sources related to environmental issues. The PLH book presents themes including descriptions and narratives of various environmental issues in several regions, including waste problems, forest conservation issues, species extinction, water, energy, food issues, and environmental-based movements.

Likewise, at KSA Assalam, environmental education at this school is more dominant than the two formal schools. Moreover, KSA has a specific subject about PLH which is also designed by itself, other materials such as Ubudiyah (including fiqh, ablution method, prayer method, and recitation), Literacy (reading and writing), and Crafts are taught for group I with an age range of 1-3 grades of Elementary School. Meanwhile for the second group, the material includes PLH, Arts (drawing, traditional music, and poetry), Indonesian, Madurese, and Tahfidz Juz Amma. Material other than PLH is taught directly in nature by linking nature and the surrounding environment into the lesson material.

Teaching materials integrated with environmental issues

Teaching materials that are integrated with environmental issues are also a characteristic of schools that applies green education. These teaching materials are very general in nature, including books, teaching modules, manual and electronic teaching media. Teaching materials can be defined as anything that is arranged systematically to support students' learning processes independently and in accordance with the applicable curriculum (Magdalena et al., 2020). Based on the survey results, the majority of teaching materials and media used at MAN Sumenep (78% and 90%) are integrated with environmental education. Ms. N explained that the teaching modules at this school were integrated with environmental education. Likewise, the learning media used is also environmentally based, such as in Arts and Culture, students used waste paper to make masks, and in Chemistry, students made environmentally friendly natural soap, namely Lerak soap and hand sanitizer made from aloe vera and lemongrass. Students also used leaf waste for biopore infiltration and compost. So in spite of textbooks for each subject, teachers also use materials from nature and both organic and non-organic waste as a medium for learning to care for the environment.

Similar to MAN Sumenep, SMA 3 Annuqayah also utilises teaching materials such as books, LKS (Student Worksheets), organic and inorganic waste. Ms. U explained that for general subjects such as Geography, she used worksheets ordered from the distributor. Meanwhile, for PLH, schools design their own student

textbooks as shown in Figure 1. Mrs. A argues that the reason why the PLH curriculum was designed by itself is because "the PLH books made by the government have not touched environmental issues critically and are not in depth". "Just for a simple context, don't litter, don't cut down trees," added Ms. U. Mrs. A also provided detailed examples of several articles quoted in the PLH book, such as the damage to the Citarum River and the stories of residents whose livelihoods depend on the river (Figure 2). According to Mrs. A, the story of the Citarum River is explained and discussed with students from upstream to downstream, including the causes of damage and the impacts caused. Then the story was linked to the rivers around the school.

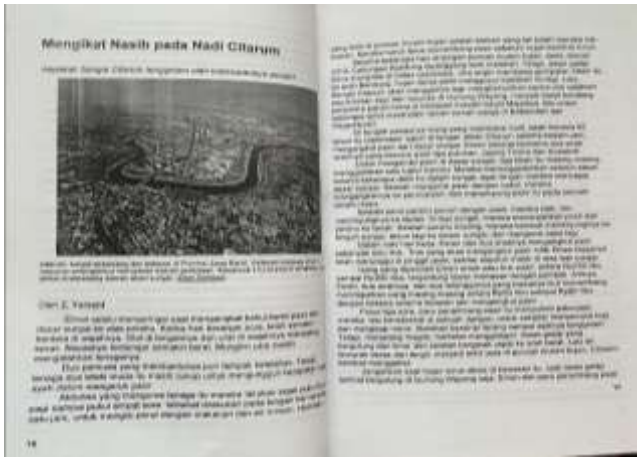

Figure 2. One of the articles quoted in the PLH book about the Citarum River
(resource: researchers' documentation)

KSA Assalam uses different teaching materials. The majority of the teaching materials are nature such as soil, plants and animals. According to Mrs. A, as one of the facilitators who teaches PLH, explained that the school also provides reading books for students, but the PLH material is mostly done directly in nature, such as planting trees, observing trees, getting to know the texture of the soil, and observing animals around the school. Besides, Mr. A, as the headmaster of the KSA, also explained that the teaching materials used for other learning materials also utilized the local wisdom of the community, such as the craft of making ketupat containers made from young coconut leaves. For arts material, students are introduced directly to traditional musical instruments, or when the lesson is about poetry, the theme is also about the environment. Additionally, Mr. A added that children are also introduced to traditional games that have begun to be forgotten so children play in nature.

Teaching methods integrated with environmental issues

The fourth aspect is the teacher's teaching method which links the material to environmental issues. Teaching method is a range of activities arranged by a teacher to facilitate students' learning so that learning objectives can be reached (Adawiyah, 2021). Survey results from teachers show that more than 78% or even 100% of teachers have used integrated teaching methods with environmental issues. In detail, when interviewed, the teachers from the three schools conveyed several teaching methods that they often used, including observation, discussion, lecture, learning by playing and hands-on practice. The teaching method used by teachers from the three schools interviewed was the hands-on method. The teachers agree that teaching environmental issues, especially in terms of waste management and protecting the environment, is through direct practicing. SMA 3 Annuqayah and MAN Sumenep students practice how to manage waste with the Waste Bank and recycle it into craft items from plastic waste or used bottles. The explanations from the teachers explained the differences between the two formal schools in implementing direct-practice methods. If MAN Sumenep focuses on maintaining and creating a clean, shady and comfortable school environment for the school community, then SMA 3 Annuqayah also has almost the same vision but also tries to educate the community through socialization activities or waste processing workshops for the wider community. At KSA Assalam, they also use direct-practice methods, especially to teach PLH. For example, "each student plants a tree in their own house and takes care of it themselves to teach that they must learn to care for the surrounding environment" said Mrs. M. KSA Assalam also uses practical methods when explaining traditional games and music as well as traditional food based on information from Mr. A.

The second method is the observation method. This method is very dominantly used in KSA Assalam based on information from the facilitators. Group 1 and group 2 students were engaged in a direct observation about the types of trees in the Assalam Conservation Garden, noting each of their characteristics and differences as well as the benefits of these trees. Students are also taught to observe several differences in soil texture and plants that are suitable for certain soil textures. The next method is learning by playing. Students at KSA Assalam learn various traditional games that have been abandoned, such as the game "Salodur" or Gobak Sodor, which is a type of traditional game played by two groups of children, where each group consists of 3-5 people. One team guards the door (usually drawn on the ground) so that the opposing team cannot pass through. The opposing team will be considered as the winner when

all its members can pass through the door without being touched by the guard team (Setiawan et al., 2013).

The next method is the lecture method combined with the discussion. Mrs. A from SMA 3 Annuqayah, explains that usually during PLH material, the teacher explains an environmental issue using the lecture method as quoted in the PLH book. The teacher tries to find any resemblance of such issue with environmental conditions in their area and then students discuss the causes and impacts led by the problem. Ms. U also added that she also discussed with her students through a questioning process regarding Geography material which was linked to environmental issues.

The above research results provide an insight into the potential and urgency of implementing green education in Sumenep, Madura. The school samples of this research have generally implemented green education with various mechanisms ranging from systems, curriculum, teaching materials and teaching methods. One of the urgencies for implementing green education in Sumenep is the massive environmental damage caused not only by waste that is not managed wisely but also by the increasing lack of productive land due to land conversion. Land conversion is a change in the initial function of part or all of a land area which has a negative impact on the environment and land productivity (Ayu & Heriawanto, 2018). Based on an investigation report carried out by the Fajar Magazine team, Student Press Institute (LPM) Institut Ilmu Keislaman Annuqayah (Instika) since 2014, around 96 ha of land has been converted, spread across 14 villages from 9 sub-districts (Fajar, 2016). The land was purchased by foreign investors and changed its function into pond land. Even today, the amount of land has probably increased after almost 10 years.

The results of surveys and interviews indicate that the implementation of green education in the three schools seeks to educate children to have insight and concern for the environment, although it is not yet fully optimal. Several things need to be evaluated and improved so that the implementation of green education can answer the environmental and living space crisis. The environmental issues discussed are limited to waste and how to deal with it. Even though the environment covers a very broad discussion including the natural, social and man-made environment to support needs (Wihardjo & Rahmayanti, 2021). Environmental issues should also touch on more complex problems, including how students are taught to care for and preserve the environment and even fight for their rights to living space. Based on the results of interviews with principals and teachers from the three schools, it is necessary to reflect on the extent of the school's role in responding to environmental issues, especially land conversion which causes a major impact on environmental damage.

The environmental education implemented at MAN Sumenep as an Adiwiyata school refers to the Adiwiyata guidelines where the aim is to create a school that is clean, shady and comfortable for the school community. Besides, the Adiwiyata school award is also an effort to improve school rankings (Parker & Prabawa-Sear, 2019). The environmental issues discussed are limited to how to manage waste and create a clean school environment and do not touch on more complex environmental issues such as land conversion. Apart from that, PLH at this school does not stand alone but is integrated with other subjects. The integration of PLH into other subjects is also applied in other schools and was effective in increasing students' understanding and attitudes about environmental issues (Alpusari, 2013).

On the other hand, environmental issues discussed at SMA 3 Annuqayah also include waste processing, food security and organic fertilizer. In terms of curriculum, this school has its own curriculum model, especially PLH. Besides, there is a specific module for the cadre system for students who are active in the PSG community which can be emulated and further developed. Environmental issues that need to be included in environment-based activities can also be added to the issue of land conversion which is concerning in Sumenep.

The implementation of green education at KSA Assalam is basically closer to environmental issues in society. This is because the spirit of the KSA establishment stemming from the founder's concerns regarding the issue of land conversion in Prancak Village. Also, environmental education at this school includes education for the community in general through socialization and environmental education for children who will be the successors and protect the productive land. Based on the narrative of Mrs. M and Mrs. A, Prancak Village and its surroundings have productive land that produces high-quality tobacco varieties and top-quality coffee varieties. Prancak tobacco has been widely researched and is a superior variety with a high selling price (Nur Qadri et al., 2024; Qadri et al., 2023; Verona et al., 2021). So that, KSA Assalam students are introduced to the potential of their village and invited to care for and maintain the potential of the land. However, learning activities at KSA have not been active since 2023 after the founder and director of KSA Assalam passed away. This is one of the weaknesses of alternative schools such as nature schools where learning activities depend on the founder or certain people who are the initiators. In contrast to the formal school system which is already well established so that there is no one or a group of people in it, the educational process remains continue. The learning system in alternative schools such as KSA needs to be strengthened so that it can run optimally.

In terms of curriculum and teaching materials for implementing green education, several teaching materials used from the three schools can be adopted. For example, PLH subjects and teaching materials developed by SMA 3 Annuqayah. These teaching materials can be developed into teaching materials that are more interactive and fun for students. For instance, one of them is by developing comic-based teaching materials as developed by Huda and Utami (2023) to support green education at the junior high school level. These teaching materials can also be adapted according to the needs of each school to make them more contextual. If, for example, a school does not have a specific PLH curriculum, the school can also adopt the implementation of green education, such as at the Adiwiyata school, MAN Sumenep by integrating it into other subjects.

In addition, the dominant teaching method applied in the three schools is the hands-on method. In line with research conducted by Maulana et al. (2024), involving students in direct practice is effective in increasing students' awareness and participation in protecting the environment. Other teaching methods applied in the three sample schools such as lecture methods, observation methods, and discussions are also often used in environmental education in general (Muslicha, 2015). The next method is learning by playing method which is applied at KSA Assalam which is also in line with research conducted by Hayati et al. (2012) that this method is suitable for forming a love of the environment in young children. Finally, it can be said that implementing green education is important and urgent to implement in Sumenep to answer the environmental crisis that is currently occurring. The implementation can refer to implementation in several schools or by designing starting from the system, curriculum, teaching materials and teaching methods that suit the needs of the school and students.

Conclusion

It can be concluded that the implementation of green education is very urgent in Sumenep, Madura to respond to environmental damage, especially that caused by land conversion. Based on the data obtained from the three school samples, this research problem can be answered, namely how formal and non-formal schools implement green education starting from the system, curriculum, teaching materials and teachers' teaching methods. The systems implemented in the three schools vary, but in general both formal schools have specific communities or programs that are active in dealing with environmental issues, such as the adiwiyata team at MAN Sumenep and PSG at SMA 3 Annuqayah. Meanwhile, KSA Assalam has a direct-learning system in the natural surroundings so that environmental education is very dominant. As for the curriculum, the two formal schools follow the curriculum set by the government, but if MAN Sumenep focuses more on integrating environmental issues into other material, then SMA 3 Annuqayah applies PLH as a separate subject. In terms of teaching materials used, they are also very diverse, starting from PLH books, textbooks in general, nature, traditional musical instruments, organic and inorganic waste and other teaching materials. The most dominant teaching method is the hands-on practice to educate children to be environmentally aware and foster concern for the environment. Moreover, there are also methods of discussion, lecture, observation and playing while learning. Generally, two formal schools had similarity in system, curriculum, teaching method, and teaching materials while the alternative school showed a distinct characteristic. Even though there are several things that need to be improved, these three schools provide new insights for other schools in implementing green education. Further research is necessary, whether quantitative, qualitative, or developing curriculum and teaching materials that are appropriate and effective for implementing green education in Sumenep.

Acknowledgments

We would like to thank the three schools as the research samples, namely MAN Sumenep, SMA 3 Annuqayah, and KSA Assalam for providing permission to conduct research and collect data and DRTPM (Direktorat Jenderal Pendidikan Tinggi Kementerian Pendidikan dan Kebudayaan Republik Indonesia) for funding the research through PDP (Penelitian Dosen Pemula) grant with contract number 109/E5/PG.02.00.PL/2024, 038/SP2H/PT/LL7/2024, 006/LPPM/PP-04/E.01/UNIJA/VI/2024.

Author Contributions

All authors have their own roles to carry out this research well. First author has contributed to data collection, data processing and analysis, and preparation of draft papers. H.,contributes for collecting literature, reviewing a paper and editing. S.A.R and R.A.S had contributed to metodhology, concept design, suggestions and project administration. All authors have read and approved the published version of the manuscript.

Funding

This research was funded by DRTPM (Direktorat Jenderal Pendidikan Tinggi Kementerian Pendidikan dan Kebudayaan Republik Indonesia), grant number 109/E5/PG.02.00.PL/2024, 038/SP2H/PT/LL7/2024, 006/LPPM/PP-04/E.01/UNIJA/VI/2024 and the APC was funded by the DRTPM as well.

Conflicts of Interest

There is no conflict of interest in this research article.

References

Adawiyah, F. (2021). Variasi Metode Mengajar Guru Dalam Mengatasi Kejenuhan Siswa Di Sekolah Menengah Pertama. *Jurnal Paris Langkis*, *2*(1), 68–82. https://doi.org/10.37304/paris.v2i1.3316

Adnyana, I. M. D. M., Mahendra, K. A., & Syed Meesam Raza. (2023). The Importance of Green Education in Indonesia: An analysis of Opportunities and Challenges. *Education Specialist*, *1*(2), 61–68. https://doi.org/10.59535/es.v1i2.168

Adnyana, I. M. D. M., & Sudaryati, N. L. G. (2022). The potency of green education-based blended learning in biology students at the Hindu University of Indonesia. *BIO-INOVED : Jurnal Biologi-Inovasi Pendidikan*, *4*(1), 1-9. https://doi.org/10.20527/bino.v4i1.11047

Alpusari, M. (2013). Analisis Kurikulum Pendidikan Lingkungan Hidup Pada Sekolah Dasar Pekanbaru. *Primary: Jurnal Pendidikan Guru Sekolah Dasar*, *2*(02), 10-17. https://ejournal.unri.ac.id/index.php/JPFKIP/article/view/1957

Anditha, A. (2018). Implementasi Pendidikan Karakter Peduli Lingkungan Di Sd Kanisius Sorowajan Banguntapan Bantul. *Jurnal Pendidikan Guru Sekolah Dasar*, *7*(18), 1–783. https://journal.student.uny.ac.id/index.php/pgsd/article/view/11599

Ayu, I. K., & Heriawanto, B. K. (2018). Perlindungan Hukum Terhadap Lahan Pertanian Akibat Terjadinya Alih Fungsi Lahan Di Indonesia. *Jurnal Ketahanan Pangan* , *2*(2), 122–130. https://jim.unisma.ac.id/index.php/JU-ke/article/view/1607-pertanian-

Biro Pengabdian Masyarakat Pondok Pesantren Annuqayah. (2021). *Komunitas Sekolah Alam*. https://bpmppa.org/komunitas-sekolah-alam-ksa/

Fajar, M. R. (2016). Investor Borong Tanah Sumenep; Penduduk Diancam, Ditakuti Ditipu. *Fajar*, *14*(5).

Hayati, N., Seriati, N. N., & Nurhayati, L. (2012). Kegiatan Bermain Berbasis Art Craft Bagi Anak Usia Dini Untuk Mempromosikan Kecintaan Pada Lingkungan. *Jurnal Kependidikan Penelitian Inovasi Pembelajaran*. *42. (2)*. 152–161. https://doi.org/https://doi.org/10.21831/jk.v42i2.2241

Huda, Q. A., & Utami, S. D. (2023). Implementation of Based Teaching Materials Green Education and Its Effect on Understanding Concepts of Junior High School Students. *Journal of Science and Social …*, *1*(1), 8–15. https://jsss.lombokinstitute.com/index.php/JISIS/article/view/4%0Ahttps://jsss.lombokinstitute.com/index.php/JISIS/article/view/4/2

Karmilasari, V., Putri, D. S., & Faedlulloh, D. (2020). Strategi Program Eco-School Dalam Menghadirkan Karakter Peduli Lingkungan. *Administratio: Jurnal Ilmiah Administrasi Publik Dan Pembangunan*. *11*.(2). 129–139. https://doi.org/10.23960/administratio.v11i2.165

Kementerian Lingkungan Hidup dan Kehutanan. (2023). *KLHK Berikan Penghargaan Adiwiyata 2023 Untuk 551 Sekolah*. https://www.menlhk.go.id/news/klhk-berikan-penghargaan-adiwiyata-2023-untuk-551-sekolah/

Li, X., Ma, L., Ruman, A. M., Iqbal, N., & Strielkowski, W. (2024). Impact of natural resource mining on sustainable economic development: The role of education and green innovation in China. *Geoscience Frontiers*, *15*(3), 1-12. https://doi.org/10.1016/j.gsf.2023.101703

Magdalena, I., Sundari, T., Nurkamilah, S., Ayu Amalia, D., & Muhammadiyah Tangerang, U. (2020). Analisis Bahan Ajar. *Jurnal Pendidikan Dan Ilmu Sosial*. *2*.(2) 311–326. https://ejournal.stitpn.ac.id/index.php/nusantara

Masirun, M., Farwitawati, R., Kamilah, F., & Khairani, Z. (2023). Program Ramah Lingkungan Melalui Kegiatan Bank Sampah Pada Sekolah Menengah Kejuruan (Smk) Perpajakan Riau Menuju Sekolah Adiwiyata. *Jurnal Pengabdian Kompetitif*, *2*(1), 21–30. https://doi.org/10.35446/pengabdian_kompetif.v2i1.1385

Maulana, H., Zufar, M., & Bagaskara, T. (2024). Edukasi Green Sustainability Meningkatkan Kualitas Lingkungan dan Pendidikan di SD Negeri Beloh. *Jurnal Pengabdian Kepada Masyarakat Mandiri(JPMM)*, *2*(2), 309–317. https://doi.org/10.556442

Meng, J., Abed, A. M., Elsehrawy, M. G., Al Agha, A., Abdullah, N., Elattar, S., Abbas, M., AL Garalleh, H., & Assilzadeh, H. (2024). Nano-integrating green and low-carbon concepts into ideological and political education in higher education institutions through K-means clustering. *Heliyon*, *10*(10).e31244. https://doi.org/10.1016/j.heliyon.2024.e31244

Mongaboy. (2019). *Menuju Sekolah Bebas Sampah Plastik di Sumenep*. https://www.mongabay.co.id/2019/11/21/menuju-sekolah-bebas-sampah-plastik-di-sumenep/

Muslicha, A. (2015). Metode Pengajaran Dalam Pendidikan Lingkungan Hidup Pada Siswa Sekolah Dasar (Studi Pada Sekolah Adiwiyata Di Dki Jakarta). *Jurnal Pendidikan*, *16*(2), 110–126. https://doi.org/10.33830/jp.v16i2.342.2015

Nizaar, M. (2022). Green Education Untuk Mengembangkan Karakter Entrepreneurship Siswa Abad 21. *Prosiding Seminar Nasional Penelitian Dan*

Pengabdian Kepada Masyarakat (Snppm) Universitas Muhammadiyah Metro, 4(1), 6-15. https://prosiding.ummetro.ac.id/index.php/snppm/article/view/91%0Ahttps://prosiding.ummetro.ac.id/index.php/snppm/article/download/91/54

Nur Qadri, S., Yamin, M., & Dzulkifli Darwis. (2024). Pengujian Viabilitas dan Vigor Benih Beberapa Varietas Tanaman Tembakau (Nicotiana tabacum L.). *Perbal: Jurnal Pertanian Berkelanjutan*, *12*(1), 128–136. https://doi.org/10.30605/perbal.v12i1.3181

One Planet Network. (2015). *Adiwiyata School Program in Indonesia.* https://www.oneplanetnetwork.org/initiative/adiwiyata-school-program-indonesia

Parker, L., & Prabawa-Sear, K. (2019). Environmental Education in Indonesia. In *Environmental Education in Indonesia: Creating Responsible Citizens in the Global South?* (Issue August 2019). Routledge. https://doi.org/10.4324/9780429397981

Pemerintah Pusat Republik Indonesia. (2003a). *Keputusan Presiden Nomor 79 Tahun 2003 Tentang Pembangunan Jembatan Surabaya-Madura.* https://peraturan.bpk.go.id/Details/56331/keppres-no-79-tahun-2003

Pemerintah Pusat Republik Indonesia. (2003b). *Undang-Undang Nomor 20 Tahun 2003 Tentang Sistem Pendidikan Nasional.* https://jdih.kemdikbud.go.id/sjdih/siperpu/dokumen/salinan/UU_tahun2003_nomor020.pdf

Pusat Pengembangan Generasi Lingkungan Hidup dan Kehutanan. (2023). *Daftar Sekolah Adiwiyata Mandiri Dan Nasional.* https://simp2sdm.menlhk.go.id/tabular/detil/ppglhk_penghargaan?filter_th=2024&filter_from_bln=Jan&filter_to_bln=Sep&bln_th_from=Jan 2024&bln_th_to=Sep 2024

Qadri, S. N., Yamin, M., & Darwis, D. (2023). Pertumbuhan Bibit Tembakau (Nicotiana tabacum L .) Beberapa Varietas Lokal dan Unggul dengan Media Polibag Growth of Tobacco Seeds (Nicotiana tabacum L .) in Several Local and Superior Varieties using Polybag Media. *Jurnal Galung Tropika*, *12*(3), 400–407. https://doi.org/10.31850/jgt.v12i3.1145

Safitri, A., Habibi, H., & Matlubah, H. (2024). Literasi Lingkungan Siswa Smp Di Daerah Kepulauan. *Prosiding SNAPP : Sosial Humaniora, Pertanian, Kesehatan Dan Teknologi*, *2*(1), 295–307. https://doi.org/10.24929/snapp.v2i1.3149

Setiawan, A., Kartikadarma, E., & Haryanto, H. (2013). Preservation of Gobak Sodor traditional games using augmented reality computer game simulation. *2013 International Conference of Information and Communication Technology, ICoICT 2013*, 235–240. https://doi.org/10.1109/ICoICT.2013.6574579

Verona, L., Diana, N. E., & Djajadi, D. (2021). Respon Petani Terhadap Varietas Unggul Baru Tembakau Madura. *Buletin Tanaman Tembakau, Serat & Minyak Industri*, *13*(1), 26. https://doi.org/10.21082/btsm.v13n1.2021.25-35

Wihardjo, R. S. D., & Rahmayanti, H. (2021). *Pendidikan Lingkungan Hidup*. PT Nasya Expanding Management.

Wina Maryuni, N. P. (2024). Penanaman Pendidikan Karakter Melalui Pengelolaan Bank Sampah di Lingkungan Sekolah. *Metta : Jurnal Ilmu Multidisiplin*, *4*(1), 126–139. https://doi.org/10.37329/metta.v4i1.2989

Wiprapto, P. (2015). Dampak Jembatan Suramadu Terhadap Pertumbuhan Ekonomi Di Kabupaten Bangkalan Dan Kabupaten Sampang. *Jurnal Ilmu Ekonomi Pembangunan*, *6*(1), 43–56. http://eprints.upnjatim.ac.id/6682/