

Development of a Plastic Waste Educational Learning Platform to Enhance Environmental Awareness of 21st Century Teacher Candidates at Syiah Kuala University

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Abstract. The increasingly complex problem of plastic waste needs to be addressed with more creative educational strategies so that people become more aware of the importance of preserving the environment. This study aims to describe the level of environmental awareness among FKIP students at Syiah Kuala University as future 21st-century teachers, covering knowledge, attitudes, and behavior, and to measure the effectiveness of learning interventions in increasing students' environmental awareness. This research uses a quantitative descriptive research method with initial data collection. The instruments used included a questionnaire that had been validated by experts to ensure data validity and reliability, and the test results showed that the instrument was suitable for use in the study. The research results indicate that the overall level of environmental awareness among students is still in the moderate category. A total of 58.99% of students' knowledge falls into the very low category, and 46.07% of students' attitudes are also in the same category. Meanwhile, in terms of behavior, 48.88% of students actually showed a high category. This finding indicates an imbalance between the cognitive, affective, and conative aspects of students' environmental awareness. To measure the effectiveness of awareness-raising efforts, a post-test was also conducted after the learning intervention, which showed a significant improvement, with the average knowledge score of students reaching 79%, attitudes 85%, and behavior 89%. Therefore, a strategy is needed to improve the quality of education thru stronger integration into the environmental education curriculum.

Keywords: Environmental awareness, 21st-century education, descriptive study, learning platform, plastic waste

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Introduction

Environmental issues have become an increasingly urgent global concern in recent decades. Climate change, pollution, land degradation, and excessive exploitation of natural resources indicate an ecological crisis that must be addressed immediately. In Indonesia, data from the Ministry of Environment and Forestry (KLHK, 2023) reports that national waste generation reaches 35.93 million tons per year, with 17% of it being plastic waste. Plastic waste, as one of the main contributors to pollution, has become a serious problem because it is difficult to decompose and has a direct impact on the health of both terrestrial and marine ecosystems (Borrelle et al., 2020). This problem is not only related to waste management, but also to the public's low awareness of the importance of protecting the environment. In this context, education plays a key role as the primary means of shaping awareness and concern for the environment. Education is not just about transferring knowledge, but also about shaping the character and attitudes of young generations in facing global challenges, including environmental crises.

Education is one of the strategic means of shaping environmental awareness and concern. UNESCO (2021), thru education for sustainable development (ESD), emphasizes that young generations need to be equipped with the knowledge, skills, and attitudes to face global challenges, including environmental crises. This aligns with the research by Olsson et al. (2022), which shows that ESD is capable of improving students' action competence, although behavioral change requires a continuous process. In the context of higher education, students in the Faculty of Education and Teacher Training (FKIP) hold a strategic position as future 21st-century teachers who not only transmit knowledge but also serve as role models in instilling environmental care values in students (Singh-Pillay, 2023).

Students, especially those pursuing education at the FKIP, play a strategic role in sustainable development. As future 21st-century teachers, they not only serve as knowledge disseminators but also as role models and drivers of social change, including in environmental sustainability. Therefore, the environmental awareness level of FKIP students needs to be deeply understood as the basis for forming environmental literacy competence for future teachers.

Environmental awareness encompasses understanding ecological issues, caring about natural conditions, and taking concrete actions in environmental conservation. However, initial observations at the FKIP at Syiah Kuala University show that environmentally friendly behavior is still low, for example, in terms of waste sorting, even tho facilities are available. This condition indicates a gap that needs to be addressed thru more integrated environmental education.

Along with the demands of the Industrial Revolution 4.0, teachers are not only required to master teaching materials, but also need to possess soft skills, new literacies, and character competencies. One important literacy is environmental literacy. By equipping FKIP students with high environmental awareness, they are expected to instill sustainability values in their students and also become agents of change in facing global ecological challenges. In this context, technological developments, particularly the advent of the internet, offer significant opportunities to support the educational process. The internet, which is now accessible to almost all segments of society, allows every individual to obtain information, learn independently, and broaden their horizons (Sukran & Huda, 2023). Hajj-Hassan et al. (2024) in a systematic review affirm that the use of digital media can increase environmental awareness and facilitate more participatory learning. Similarly, Khalifé et al. (2022) emphasized the importance of digital innovation in environmental education to overcome the limitations of conventional methods.

On the other hand, the development of digital technology provides new opportunities for the world of education. The presence of the internet and learning platforms allows the

learning process to become more flexible, interactive, and contextual. Research by Yunita & Elihami (2021), indicates that using learning platforms can improve learning effectiveness while also fostering changes in students' attitudes and behaviors. Therefore, the development of an environmental education-based learning platform is considered relevant for raising awareness among prospective teacher students, particularly regarding plastic waste management.

Previous research indicates that students' levels of environmental awareness remain varied and tend to be suboptimal. A study by Ma'ruf et al. (2016) revealed that although students' knowledge and attitudes toward environmental issues fall into the high category, their actual behaviors, such as waste management and energy conservation, remain relatively low. Similar findings were reported by Handoyo et al. (2021), who identified a gap between students' environmental awareness and their daily practices.

Despite various environmental education programs being implemented among students, pro-environmental behavior change does not always align with the increase in knowledge gained. Additionally, Mkumbachi et al. (2024) found that while students possess sound ecological knowledge, it is not consistently translated into pro-environmental behavior. This finding aligns with Erwinsyah (2022), who highlighted that students' attitudes and understanding of environmental issues are not always internalized into habitual or tangible actions. Moreover, student engagement in environmental activities is influenced by the existing learning structures in higher education institutions. Muniz et al. (2025) emphasized that limited integration of environmental content into the core curriculum hinders the development of active student participation in environmental initiatives.

Unlike previous studies that focused more on knowledge or attitude alone, this study comprehensively highlights the environmental awareness of FKIP students by integrating knowledge, attitude, and behavior dimensions. This focus is considered important because 21st-century teacher candidates are expected not only to understand environmental issues but also to demonstrate real-world practices as role models for their students (Eroğlu, et al., 2025). Additionally, this research offers a fresh perspective by utilizing digital platforms as an educational tool, which is expected to bridge the gap between understanding and behavior. This approach aligns with recent international research findings that emphasize the effectiveness of digital media in raising ecological awareness (Hajj-Hassan et al., 2024; Dzamtoska-Zdravkovska & Haque, 2025; Khalifé et al., 2022), but the context of education students in Indonesia is still rarely explored in depth. The findings indicate a gap between understanding and practice regarding environmental awareness among students, particularly future teachers. This reinforces the urgency of conducting an in-depth and contextual study to describe the actual state of environmental awareness among FKIP students. The descriptive approach is considered appropriate for providing a comprehensive overview of students' knowledge, attitudes, and behaviors regarding environmental issues, so that the results can be used as a basis for formulating more effective environmental education strategies.

Furthermore, this research was conducted to fill a gap in the study of environmental awareness among students in the Faculty of Education and Teacher Training who are preparing for 21st-century teaching. The focus on education students from various study programs in general is the main strength of this study, considering the importance of all teachers from various disciplines participating in instilling environmental care values. This study also offers a new reading of how the dimension of environmental awareness is understood and practiced by pre-service teachers in the context of the digital and sustainability era. The purpose of this study is to describe the level of environmental awareness among students at the Faculty of Education and Teacher Training (FKIP) at Syiah Kuala University, including knowledge, attitudes, and behavior, and to analyze the role of digital learning platforms in supporting the enhancement of this awareness. With

this aim, the research is expected to provide an empirical basis for formulating more effective environmental education strategies for 21st-century prospective teachers.

Methods

The method used in this study is research and development (R&D). Development research is used to develop and validate a product (Rustamana et al., 2024). R&D is research conducted with the aim of producing a specific product and then testing the effectiveness of the developed product (Anafi et al., 2021). This method aims to develop a learning platform product. The product developed in this study is a learning platform designed to raise students' environmental awareness, particularly in plastic waste management. The development model used in this development research is the ADDIE model (analysis, design, development, implementation, and evaluation). The analysis phase was conducted to identify needs, followed by design planning to design a learning platform using the WordPress application. Next, during the product development phase, the developed learning platform was validated by experts consisting of media experts and content experts. After validation and being declared suitable for implementation, the implementation phase began, where the learning platform was distributed to students at Syiah Kuala University's FKIP.

The field trial used a one-group pre-test and post-test design, which involved administering an environmental awareness questionnaire before (T1) and after (T2) using the learning platform. The population in this study is the students of Syiah Kuala University. Meanwhile, a sample is one of the characteristic elements of a population that is to be made an object or subject of research (Jasmalinda, 2021). The sample for this study consisted of 158 students from the FKIP. In this study, the sampling technique used is the Random Sampling technique, which is a sampling technique where every member of the population has an equal chance of being selected to be part of the sample.

The instruments used for data collection in this study were an instrument validation sheet by 2 experts, used to assess the feasibility of the learning platform, and a student environmental awareness questionnaire to examine the increase in student awareness before and after using the learning platform. Data were analyzed descriptively and quantitatively thru percentage calculations, and a paired sample t-test was used to determine the significance of the increase in student awareness after using the platform. Data analysis uses the percentage of ratings in Table 1.

Table 1. Percentage score assessment

No	Score assessment (%)	Category
1	>65.75	Very high
2	61-65-75	High
3	56.32-61	Low
4	<56.32	Very low

(Sumber: Hasanah et al., 2023)

Results and Discussion

The development undertaken is an implementation of the ADDIE development model stages, which consist of analysis, initial product design, product development, product implementation, and the final stage, product evaluation (Aydin et al., 2023). The product produced is interactive software-based learning media designed to support the learning process, educate about how to process plastic waste, and raise students' awareness of the importance of maintaining a safe environment.

Analysis Phase

A needs analysis was conducted on 55 students at Syiah Kuala University. This needs analysis aims to determine what students need by distributing a needs questionnaire. Based on the data from the questionnaires that have been distributed, it is hoped that this will provide information about students in the learning process. Additionally, the purpose of conducting a needs analysis is to help the researcher better understand the existing gap between the desired final outcome and the students' knowledge. Researchers distributed a needs analysis questionnaire using google forms, which contained statements related to issues of inequality occurring within the student environment. The questionnaire filling technique for student needs analysis uses the Likert scale. From the results of the questionnaire, all student needs were then elaborated and analyzed as an initial step in developing a learning platform product.

Based on the results obtained, it shows that there are several significant gaps in the students' learning environment regarding environmental awareness, specifically in plastic waste management. These gaps include a lack of awareness and knowledge in plastic waste management, limited access to learning resources and education specifically addressing environmental issues for students, and limited use of technology that can increase students' awareness and participation in addressing environmental problems and the concrete actions taken by students. This is evident from several questions in the questionnaire that are confusing regarding the statement above, which were answered by the students. Based on the overall results of the student needs questionnaire, it can be seen that there are 20 statement indicators answered by 55 students. The data obtained from student responses, based on the sum of all percentage scores divided by the number of statement items, resulted in the following percentages: 0% of students strongly disagreed (STS), 2% disagreed (TS), 50% agreed (S), and 48% strongly agreed (SS). The overall percentage results showed that the majority of responses fell into the agree (S) category, followed by the strongly agree (SS) category, with percentages of 50% and 48% respectively. This indicates that students need a learning platform to raise environmental awareness, especially regarding plastic waste management. The lack of understanding and minimal initiative among students in implementing environmentally friendly practices is the main factor of concern. Additionally, limited access to information is also a constraint that hinders efforts to raise environmental awareness among students. Therefore, the development of this platform must also include guidelines for recycling plastic waste, in order to increase real action in the processing of plastic waste.

Design Phase

The design phase is where the researcher begins to develop the initial design for the learning platform. At this stage, the focus to be used in the learning platform is determined, with the aim of raising environmental awareness. The results of the needs analysis obtained previously serve as the foundation for determining the form and content of the learning platform design, ensuring it meets the needs of students, especially in helping them understand and find solutions to plastic waste problems. With careful planning. This learning platform was developed using wordpress, a flexible and user-friendly content management system (CMS) for creating digital learning websites. The choice of wordpress as the development medium was based on its various advantages, such as ease of content management, ease of creating websites of any complexity, and its ability to provide interactive features (Mambetniyazov, 2021)

Development Phase

The development steps at this stage are to validate the learning platform with media experts and content experts. Validation is carried out to assess the validity of the learning platform product, which will later be tested on students at the FKIP at Syiah Kuala University. After validation is complete, revisions to the learning platform need to be made based on the suggestions and input received.

Table 2. Summary of media and material validation results

No	Validation aspect	Score obtained		Maximum score	Results (%)	
		V1	V2		V1	V2
1	Media	66	64	75	88	85
2	Materi	60	64	75	80	85

Based on the summary table of validation results above, it can be concluded that the learning platform developed by the researcher can be used and is suitable for testing on students. This is demonstrated by the assessment results provided by the four expert validators, where each validator gave a percentage of 85 and 88% for the media aspect. Meanwhile, for the material aspect, two expert validators gave percentages of 80% and 85%. Based on these results, it can be concluded that the learning platform developed to increase students' environmental awareness in plastic waste management is in the "Very Valid" category and is suitable for implementation in the learning process. The use of this learning platform is expected to help students increase their awareness of environmental issues, particularly in plastic waste management. Environmental awareness regarding plastic waste management is very important, as it influences sustainable behavior and practices (Wijayanto et al., 2024). Thus, the development of this learning platform not only meets the criteria for feasibility in terms of content and media, but also has the potential to be an effective educational tool in shaping environmental awareness among students. The validation that has been carried out shows that the material and media presented are able to attract attention and provide a deep understanding of the importance of plastic waste management. Through the development of this learning platform, students can be more motivated to apply environmentally friendly behavior in their daily lives.

Implementation Phase

The next stage is the implementation phase on the validated learning platform product. This application is being implemented at Syiah Kuala University. The purpose of implementing this learning platform is to test hypotheses related to measuring students' level of environmental awareness. Students are encouraged to start by taking a pretest to assess their initial understanding and determine their baseline knowledge before using the learning platform. After completing the pretest, students are advised to read the materials provided on the learning platform. Subsequently, students are encouraged to take a posttest to gauge their level of awareness after using the learning platform. The results of the learning platform development can be seen at the following link: <https://pengolahanlimbahplastik.wordpress.com/tentang/>

Trial Phase

During the trial phase, the development of the learning platform regarding plastic waste management enters a crucial stage to measure the extent to which the initial design that has been developed is able to meet the established learning objectives. The trial was conducted on a small group of target users, in this case, students or the public who are the primary target of the platform. This process aims to evaluate various important aspects such as content effectiveness, user interface appearance, ease of navigation, and user appeal and engagement while using the platform.

During this stage, users are asked to access various features and modules available on the platform, including learning materials and educational videos. Data collection was conducted through a questionnaire on students' environmental awareness before and after using the learning platform to assess changes in knowledge, attitudes, and behavior towards the issue of plastic waste management.

The results of this trial phase provide a clear picture of the strengths and weaknesses of the developed learning platform. For example, if it's found that users are having difficulty understanding the learning flow or that certain features aren't working optimally, the developers will revise and improve those aspects. Additionally, user responses are also used to assess the extent to which the platform is able to promote increased environmental awareness, particularly in terms of recycling practices and sustainable plastic waste management.

This stage serves not only as validation of the initial design but also as an instrument to ensure that the developed platform is truly relevant, beneficial, and meets user needs. Thus, the results of the trial stage become an important foundation for refining the Learning Platform before it is implemented on a wider scale.

Initial State of Environmental Awareness Among Students

The results of the study on knowledge levels were based on a sample of 158 individuals. The initial condition of students' environmental awareness reflects their daily practices.

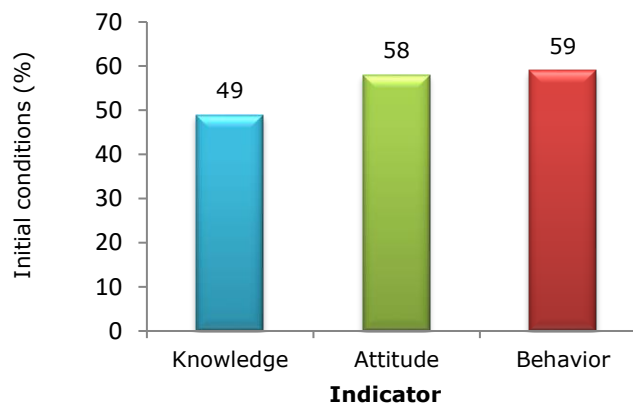


Figure 1. Initial student attitudes towards the environmen

The graph above shows that most students still have a low level of knowledge regarding environmental issues, particularly in plastic waste management. As many as 49% of the sample showed a poor level of mastery and understanding of the statements presented in the questionnaire regarding the impact of plastic waste, the recycling process, and the role of individuals in reducing single-use plastic consumption. In terms of attitude, the percentage obtained was 58%. This is evidenced by the fact that many students still show a lack of concern and are not very active in supporting environmental conservation efforts. This low level of concern can be attributed to several factors, such as a lack of individual awareness regarding the impact of plastic waste on the environment, limited supporting facilities on campus, minimal involvement in environmental activities, and the weak influence of environmental education in shaping environmentally friendly attitudes and habits. In terms of behavior, the percentage obtained was 59%. This indicates that some students are still unaware of good actions for the environment. This finding indicates that shaping positive environmental behavior among students remains a significant challenge. Many of them haven't yet developed consistent habits or concerns for environmental sustainability, such as disposing of waste properly, conserving energy, or participating in recycling activities. Plastic waste recycling refers to the waste processing process that collects plastic waste materials and converts them into reusable raw materials to produce other valuable products. Recycling is not only a method for disposing of plastic, but also an effective process for minimizing the need for new plastic (Damayanti et al., 2022; Macheca et al., 2024).

The results of the study on the knowledge level of the sample after receiving learning by applying platform-based learning are presented in the Figure 2.

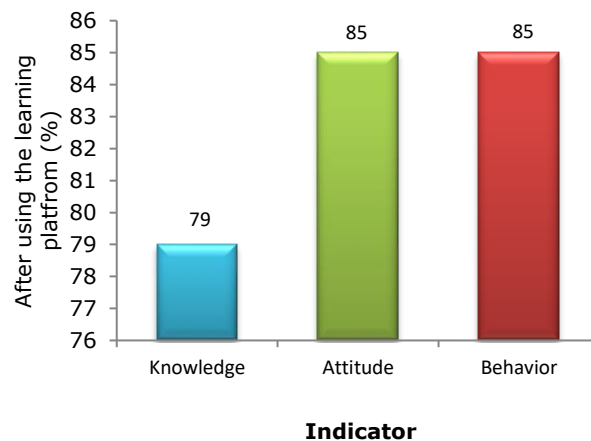


Figure 2. Condition after using the learning platform

Based on the research data, there was a significant increase in students' environmental awareness regarding plastic waste management after the implementation of platform-based learning. After learning through the use of a learning platform designed with interactive materials, educational videos, and relevant images related to plastic waste management, there was a quite significant increase. The data from the final questionnaire results show that 79% of students responded positively to the aspect of environmental knowledge. For the aspects of attitude and behavior, 85% was obtained for each. This indicates active interaction in the learning process. Based on the results of the hypothesis test using the t-test, there was a significant improvement in the three aspects tested. The results of the hypothesis test can be seen in Table 3 for each of the three aspects

Table 3. Hypothesis test results

Aspect	Sig	Decision
Knowledge	0.000	There is an increase
Attitude	0.000	There is an increase
Behavior	0.000	There is an increase

Learning platforms can encourage students to think critically, understand the real impact of plastic waste on the environment, and realize the role students must play in being responsible for environmental sustainability. Community involvement and legislative tools are crucial for addressing the growing plastic pollution crisis (Khaerani, 2021). This indicates that learning through the learning platform not only enhances students' knowledge, attitudes, and behaviors but also encourages them to implement real actions in their daily lives. Students are starting to show more environmentally conscious behavior. This change demonstrates the success of interactive learning approaches in fostering environmental awareness values. Interactive learning plays a crucial role in shaping public perceptions and attitudes towards plastic waste, advocating for sustainable policies, and educating the community about environmental consequences, thereby influencing pro-environmental behavior (Fauzi & Nugrahani, 2023). Public awareness of the environment and related issues, and developing the necessary skills, expertise, attitudes, and motivation to make informed decisions and take responsible action (Mahanta, 2023).

Environmental awareness refers to the extent to which individuals recognize their surroundings and understand their interactions with the environment. It involves the ability to observe, comprehend, and reflect on environmental conditions and changes (Gabriella & Sugiarto, 2020). Furthermore, community participation in waste management and environmental cleanliness plays a crucial role, underscoring the need for collective efforts to address environmental challenges (Hurulean & Sugiyanto, 2022; Windarto & Martini, 2021). This form of awareness is essential in shaping individual attitudes and behaviors toward various environmental concerns, including waste management, natural resource utilization, and social responsibility.

Understanding students' levels of environmental awareness provides an initial indication of their preparedness to become agents of change amid increasingly complex global challenges. Consistent with Kartadireja (2024) findings, students' environmental awareness and communication skills are key factors that influence their capacity to support environmental initiatives. In the context of 21st-century teacher candidates, environmental awareness extends beyond cognitive dimensions such as knowledge; it also encompasses the values, attitudes, and concerns they will bring into their future teaching practices. This issue is particularly important, as teachers serve not only as conveyors of knowledge but also as role models in shaping students' character and behavior, including their environmental awareness. Malik & Sharma (2022) emphasized that educating students can enhance their understanding of environmental degradation and their ability to contribute to its mitigation.

Therefore, cultivating environmental awareness among prospective teachers must be an integral component of their education. These values should not only be understood theoretically but also be translated into concrete actions. This highlights the necessity of implementing systematic, structured, and contextually relevant learning strategies and educational approaches that align with students' lived experiences, fostering genuine awareness and a sustained commitment to environmentally responsible behavior. According to Despriana & Rianti (2024), environmental conservation is vital for nurturing environmental responsibility, particularly among the younger generation. Increasing attention to issues such as climate change, species extinction, and pollution further reinforces the urgency of this effort. Jayadinata et al. (2024). similarly argued that a lack of individual awareness in protecting the environment can lead to numerous long-term problems.

Students' awareness and understanding of the negative impacts of plastic waste on the environment remain suboptimal. This lack of knowledge may hinder environmental conservation efforts and the development of environmentally responsible behaviors among students. This finding aligns with Mahanta (2023), who argued that environmental awareness is crucial among young learners to discourage the excessive use of environmental resources. Therefore, more effective strategies are needed to deliver environmental education, both through integration into the academic curriculum and extracurricular activities that encourage active student engagement in environmental issues, particularly in the management and reduction of plastic waste. These efforts are expected to enhance students' environmental knowledge and empower them to become agents of change, committed to environmental sustainability.

Previous research suggests that practical, action-based environmental education can significantly enhance students' environmental awareness and promote behavioral

change (Noverita & Darliana 2024); Rahayu et al., 2024). Environmental education can empower students to become agents of change, promoting a more environmentally conscious society (Islamiati & Saputra, 2021; Nurhasanah, 2024). Students' environmental awareness can lead to positive shifts in their daily habits. Chan et al. (2019) argued that it is essential to introduce environmental values to the younger generation at an early age. Such awareness extends beyond environmental knowledge, encompassing attitudes and concrete actions that reflect concern for the preservation of nature.

Nevertheless, the level of environmental awareness among students cannot be generalized evenly, as it is influenced by various internal and external factors. Based on research conducted by Susilo & Sarkowi (2018) showed that students' environmental awareness varies depending on their background, experience, and exposure to environmental education. In this context, it is essential to foster an educational approach that extends beyond cognitive development to encompass character building and social responsibility in response to global issues, such as the environmental crisis. Saputra et al. (2023) emphasized that character education incorporating environmental values is a long-term investment in cultivating a sustainable and environmentally responsible society. Likewise, Meika & Putra (2021) argued that instilling environmental awareness in prospective educators can establish a strong foundation for future generations who are environmentally conscious and responsible.

Through targeted and continuous education, students can be equipped with the knowledge, attitudes, and skills necessary to promote environmentally responsible behaviour. Gabriella & Sugiarto (2020) defined such behavior as actions aimed at minimizing environmental damage. Moreover, the support of educational institutions in providing contextual and collaborative learning environments is critical in fostering robust and lasting environmental awareness. University policies aligned with green campus initiatives, such as waste separation and the use of renewable energy, can significantly influence students' environmental behavior. Azis (2019) further noted that the success of green campus programs depends not only on environmental knowledge but also on the implementation of policies and the availability of facilities that encourage student participation in maintaining environmental sustainability.

As future educators in the 21st century, FKIP students play a strategic role in instilling environmental awareness values in future generations. According to Bagaskara et al. (2025), the environmental awareness of FKIP students must be developed comprehensively to enable them to become agents of change who can inspire younger students to protect and preserve the environment from an early age. Understanding the importance of sustainability principles and engaging directly in environmental programs can motivate individuals to act more responsibly. Therefore, the development of environmental awareness should extend beyond academic competencies and be reinforced through experiential learning, including community service activities, environmental projects, and PBL focused on local environmental issues.

Engaging students in activities that cultivate environmental sensitivity, such as recycling, conservation, and waste management, can foster deeper understanding and a heightened sense of responsibility. In line with Irhas et al. (2020), participation in campus-based environmental initiatives enhances personal accountability toward sustainability and encourages environmentally conscious behavior both on and off campus. Similarly, Purnomo et al. (2023) found that students accustomed to practicing waste management

on campus are more likely to apply similar habits at home or within their communities. The integration of environmental education into the curriculum and campus activities ensures that students not only gain theoretical knowledge but also apply sustainable principles in their daily lives.

In line with this, environmental education efforts should not only focus on increasing knowledge, but also be translated into concrete actions to have a wider impact. Previous research conducted by previous research by Rezeki et al. (2022) suggested that action-based educational programs can positively influence individual habits and amplify their environmental impact beyond university boundaries. Lasaiba (2023) also noted that participation in environmental programs enhances awareness and encourages responsible waste management and resource efficiency. This notion is supported by Angela (2023), who reported that education and active involvement in sustainability programs significantly improve awareness of natural resource management. Moridu et al. (2023) further emphasized that an understanding of sustainability principles, combined with hands-on experience, fosters more responsible behavior in resource management and supports long-term sustainability goals.

Implementing the concept of sustainability on campus is becoming increasingly relevant to discuss because it can serve as a real example for students in shaping pro-environmental behavior. In line with the research conducted by Putri et al. (2024) highlighted that the implementation of green campus principles, such as waste reduction and the use of renewable energy, can promote behavioral change and encourage active student participation in maintaining environmental sustainability. By embracing the green campus concept, students gain practical opportunities to learn about and implement sustainable environmental practices in everyday life (Bagaskara et al. 2025).

University policies that support sustainability, such as embedding environmental content into the curriculum and providing adequate facilities, can significantly enhance student awareness and participation in cultivating environmentally responsible attitudes (Dias et al., 2024). Dewi (2023) asserted that green education serves as an effective approach to addressing environmental issues before they escalate. Priatna (2020) also described green education as an effort to shape students' character, behavior, awareness, and environmental concern. One of the key objectives of environmental education is to provide individuals with the opportunity to develop the attitudes, values, knowledge, and commitment necessary to protect and improve the environment.

Various efforts are necessary to ensure that FKIP students not only understand the importance of environmental conservation from a theoretical perspective but are also capable of applying it practically in both their personal and professional lives. As future educators, they will serve as role models for sustainable living. In the long term, strong environmental awareness among prospective teachers will provide a crucial foundation for education that prioritizes sustainability and fosters a generation that is more caring and responsible toward the environment. Within this context, integrating the values of eco-pedagogy and the principles of sustainable education into the curriculum is of paramount importance. Prospective teachers must not only possess environmental knowledge but also demonstrate moral sensitivity and ecological ethics in their decision-making, both in the classroom and within the broader community.

Environmental literacy is an important foundation that must be strengthened so that students have more sustainable knowledge and behavioral direction. research

conducted by Yusup (2021) emphasized the importance of enhancing environmental literacy among FKIP students as a key step toward cultivating sustainable, pro-environmental behavior. Similarly, Nasution (2021) argued that awareness developed through education and academic engagement with environmental issues contributes significantly to students' environmental literacy. Consequently, a transformative approach to environmental education is required, one that moves beyond cognitive understanding and promotes active student participation through experiential learning, contextual application, and real-world engagement. Such an approach will empower students to become conscious and responsible agents of change in addressing environmental challenges. Therefore, the development of environmental awareness among FKIP students must be both strategic and continuous, involving collaboration between lecturers, academic institutions, and supportive campus policies. Only through such integrated efforts can higher education fulfill its role as a true agent of change in building a sustainable future.

Evaluation Phase

The evaluation stage is conducted continuously at each stage of this research process to ensure the quality and suitability of the developed learning platform. In the analysis stage, evaluation is carried out through the results of the needs questionnaire analysis filled out by students, in order to obtain an initial overview of learning needs and conditions in the field. Subsequently, in the planning stage, the learning platform is developed. In the development stage, a more in-depth evaluation is conducted involving an expert team, in order to assess the feasibility, clarity of the material, and suitability of the learning platform. After revision, it will be tested on students.

Conclusion

This research confirms that environmental issues, particularly the problem of plastic waste, demand innovative and sustainable educational strategies. The research results indicate that the environmental awareness level of FKIP students at Syiah Kuala University, as future 21st-century teachers, is still not optimal, particularly in the aspect of pro-environmental behavior, even though their knowledge and attitudes are already in the good category. Learning interventions through a waste plastic processing-based learning platform have proven effective in comprehensively increasing students' environmental awareness, encompassing knowledge, attitudes, and behavior. This indicates that the use of digital technology in education not only strengthens theoretical understanding but is also capable of fostering positive attitude changes and concrete actions in preserving environmental sustainability. Thus, this research successfully addresses the need for relevant, contextual learning media that meets the demands of the digital age, while also supporting the development of 21st-century teacher candidates who are caring, have strong character, and are ready to be agents of change in facing global ecological challenges.

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References

- Angela, F. (2023). Strategi Pengembangan Ekowisata Dalam Mendukung Konservasi Alam Danau Tahai [Ecotourism Development Strategy to Support Tahai Lake Nature Conservation]. *JIM: Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, 8(3), 984–993. <http://jim.unsyiah.ac.id/sejarah/mm>
- Anafi, K., Wiryokusumo, I., & Leksono, I.P. (2021). Pengembangan Media Pembelajaran Model Addie Menggunakan Software Unity 3D [Development of Addie Model Learning Media Using Unity 3D Software]. *Jurnal Education and Development*, 9(4), 433–438. <https://www.neliti.com/publications/562409/>
- Aydin, A., Gürsoy, A., & Karal, H. 2023. Mobile care app development process: using the ADDIE model to manage symptoms after breast cancer surgery (step 1). *Discover Oncology*, 14(1), lengkapi halamannya!. <https://doi.org/10.1007/s12672-023-00676-5>
- Azis, A. 2019. Kajian psikologi konservasi untuk pengembangan sdm melalui program go green (studi kasus pada mahasiswa penghuni rusunawa UNNES). *Jurnal Psikologi Ilmiah*. 7(1): 83–90. <https://doi.org/10.23887/jppsh.v6i2.50493>
- Bagaskar, F.R, Pratama, A., Armayoga, B., & Murtadho, A,. 2025. Studi tentang dampak green campus terhadap kesadaran lingkungan mahasiswa Di UIN Raden Intan Lampung, *Jurnal Ilmiah Pendidikan Dasar*. 10(3):42–64. <https://doi.org/10.23969/jp.v9i04.21558>
- Borrelle, S.B., Ringma, J., Law, K.L., Monnahan, C.C., Lebreton, L., McGivern, A., Murphy, E., Jambeck, J., Leonard, G.H., Hilleary, M.A., Eriksen, M., Possingham, H.P., De Frond, H., Gerber, L.R., Polidoro, B., Tahir, A., Bernard, M., Mallos, N., Barnes, M., & Rochman, C.M. 2020. Predicted growth in plastic waste exceeds efforts to mitigate plastic pollution. *A Science Partner Journal*, 369(6510):1515–1518. <https://doi.org/10.1126/science.aba3656>
- Chan, F., Kurniawan, R., Oktavia, A., Dewi, C., Sari, A., Khairadi, P., & Piolita, S. 2019. Gerakan peduli lingkungan di sekolah dasar Adi Widya. *Jurnal Pendidikan Dasar*, 4(2): 190. <https://doi.org/10.25078/aw.v4i2.1126>
- Damayanti, D., Saputri, D.R., Septian, D., Marpaung, S., Yusupandi, F., Sanjaya, A., Simbolon, Y.M., Asmarani, W., Ulfa, M., & Wu, H. (2022). Current Prospects for Plastic Waste Treatment. *Journal Polymers*, 14(3133), 3–29. <https://doi.org/10.3390/polym14153133>
- Dewi, K.H. 2023. Indonesian women and local politics. *US Press, 2015. JSTOR*,1(4):108–140. <https://doi.org/10.2307/j.ctv1nth4c.13>
- Dias, A., Revalina, N., Avrilia, D., Stevanie, F., Aurelly, F., & Irawan, B. 2024. Upaya pelestarian lingkungan hidup dengan mengurangi sampah plastik di fakultas matematika dan ilmu pengetahuan alam Universitas Negeri Semarang. *Jurnal Majemuk*, 3(2):304–317. <http://jurnalilmiah.org/journal/index.php/majemuk>
- Dzamtoska-Zdravkovska, S., & Haque, M.I. (2025). The influence of digital media on climate change awareness, action, and perceived barriers among UAE university students. *International Journal of Education and Sustainability*. 11(17):2335–2350. <https://doi.org/10.64252/50qt6x84>
- Erwinsyah, E. 2022. Environmental knowledge, attitudes, and practices for behavior change of university students: The case of Indonesia. *Journal of STEAM Education*, 5(2):181–192. <https://doi.org/10.55290/steam.1075516>

- Eroğlu, E., Dev, D., & Dalgin, T. 2025. Exploring the moderating role of university environmental performance in shaping students' environmental awareness and behaviors. *International Journal of Sustainability in Higher Education*, 17(2), xx-yy <https://doi.org/10.1108/IJSHE-05-2024-0323>
- Fauzi, M.F., & Nugrahani, H.S.D. 2023. Motives of environmental coverages by north european mass media: the role of three nordic countries on combating plastic waste. *RSF Conference Series: Business, Management and Social Sciences*, 3(3): 38–45. <https://doi.org/10.31098/bmss.v3i3.689>
- Febrianti, S., Fidhyallah, N.F., & Amalia, A.S. 2022. Efektifitas penggunaan media e-learning dalam pembelajaran daring. *Jurnal Ekonomi dan Pendidikan*, 19(2): 203–210. <https://doi.org/10.21831/jep.v19i2.54999>
- Gabriella, D.A., & Sugiarto, A. 2020. Kesadaran dan perilaku ramah lingkungan mahasiswa di kampus. *Jurnal Ilmu Sosial Dan Humaniora*, 9(2), 263-. <https://doi.org/10.23887/jish-undiksha.v9i2.21061>
- Handoyo, B., Astina, I.K., & Mkumbachi, R.L. 2021. Students' environmental awareness and pro-environmental behaviour: preliminary study of geography students at state University Of Malang. *IOP Conference Series: Earth and Environmental Science*, 683(1) :12049. <https://citeus.um.ac.id/jpg/vol25/iss2/6>
- Hajj-Hassan, M., Chaker, R., & Cederqvist, A.M. 2024. Environmental education: A systematic review on the use of digital tools for fostering sustainability awareness. *Sustainability Journal*, 16(9):3733. <https://doi.org/10.3390/su16093733>
- Hurulean., E.A., & Sugiyanto. 2022. Community participation in waste management as a mediation of the effect of realigy understanding on environmental cleanliness in your district, Dogiyai Regency, Papua. *International Journal of Social Science*, 1(5):757–766. <https://doi.org/10.53625/ijss.v1i5.1320>
- Irhas, M.I., Sugandini, D., Sukarno, A., Kundarto, M., Arundati, R., Berliana, N., Dari, D., & Klaster, H. 2020. Perilaku pro-lingkungan pada mahasiswa. Yogyakarta : Zahira Publishing.
- Islamiati, D.F., & Saputra, P.P. 2021. Analisis fenomena tren green lifestyle pada mahasiswa Universitas Bangka Belitung. *Jurnal Studi Inovasi*, 1(2):30–38. <https://doi.org/10.52000/jsi.v1i2.22>
- Jasmalinda. 2021. Pengaruh citra merek dan kualitas produk terhadap keputusan pembelian konsumen motor yamaha di kabupaten padang pariaman. *Jurnal Inovasi Penelitian*, 1(10):2199–2205. <https://doi.org/10.47492/jip.v1i10.422>
- Jayadinata, A.K., Muqodas, I., & Ardiyanti, D. 2024. Kesadaran lingkungan calon guru sebagai nilai karakter kepedulian lingkungan hidup. *Jurnal Konseling Dan Pendidikan*, 12(2), 12-xx. <https://doi.org/10.29210/1112000>
- Kartadireja, W.N. 2024. Dinamika pengetahuan , kesadaran , dan kemampuan [lengkapi terjemahannya!]. *Jurnal Onoma*. 10(2): 1347–1360. <https://doi.org/10.30605/onoma.v10i2.3310>
- Khaerani, T.R. 2021. Inovasi kebijakan pengurangan sampah plastik di Kota Balikpapan. *Jurnal MODERAT*, 7(3):556. <https://ojs.unigal.ac.id/index.php/modrat/article/download/2486/1893/8709>
- Khalifé, M., Chaker, R., & El Hage, H. 2022. Environmental education and digital solutions: An analysis of the Lebanese context's existing and possible digital actions. *Frontiers in Education*, 7,(943056). <https://doi.org/10.3389/feduc.2022.943056>

- Khalifé, E., Lhoste, É., & Venturini, T. (2022). Digital innovation in environmental education: Overcoming the limitations of conventional methods. *Environmental Education Research*, 11(2): 726-730. <https://doi.org/10.18421/TEM112-28>
- Lasaiba, I. 2023. Menggugah kesadaran ekologis: pendekatan biologi untuk pendidikan berkelanjutan. *Jurnal Jendela Pengetahuan*, 16(2):143-163. <https://ojs3.unpatti.ac.id/index.php/jp/article/view/10206>
- Ma'ruf, M., Surya, S., & Apriliany, P.D. 2016. Knowledge, attitudes and behavior of university students towards environmental issues in Indonesia. *Sains Humanika*, 8(1-2), xx-yy. <https://doi.org/10.11113/sh.v8n1-2.836>
- Macheca, A.D., Mutuma, B., Adalima, J.L., Midheme, E., Lucas, L.H.M., Ochanda, V. K., & Mhlanga, S. D. 2024. Perspectives on plastic waste management: challenges and possible solutions to ensure its sustainable use. *Recycling*, 9(5). <https://doi.org/10.3390/recycling9050077>
- Mahanta, B. 2023. Environmental awareness among higher education students. *International journal for multidisciplinary research*, 5(5):1-10. <https://doi.org/10.36948/ijfmr.2023.v05i05.7040>
- Malik, R., & Sharma, A. 2022. Investigating role of community college and student responses towards awareness on electric vehicles as a solution to environmental problems. *International Journal of Health Sciences*, 6(3):2632-2648. <https://doi.org/10.53730/ijhs.v6ns8.12684>
- Mambetniyazov, M. 2021. Wordpress opportunities in creating educational sites. *heoretical and empirical scientific research* 1 : 204-205. <https://doi.org/10.36074/logos-28.05.2021.v1.62>
- Meika, R.D.S., & Putra, E.D. 2021. Peran guru dalam membentuk karakter siswa peduli terhadap lingkungan pada sekolah adiwiyata di SD Mimbar Ilmu, *Ejournal Undiksha* 26(3):346. <https://doi.org/10.23887/mi.v26i3.39617>
- Mkumbachi, R.L., Astina, I.K., & Handoyo, B. 2024. Environmental awareness and pro-environmental behavior: A case of university students in Malang city. *Jurnal Pendidikan Geografi: Kajian, Teori, Dan Praktek Dalam Bidang Pendidikan Dan Ilmu Geografi*, 25(2):6. <https://doi.org/10.17977/um017v25i22020p161>
- Moridu, I., Melinda, P.A., Sidik, F.R., & Asfahani. 2023. Edukasi keberlanjutan lingkungan melalui program komunitas hijau untuk menginspirasi aksi bersama. *Communnity Development Journal*, 4(4):7121-7128. <https://journal.universitaspahlawan.ac.id/index.php/cdj/article/view/18699>
- Nasution, R. 2021. Analisis tingkat literasi lingkungan mahasiswa FKIP Universitas Mulawarman dengan transformasi skor NELA (National Environmental Literacy Assessment). *Jurnal Ilmiah BioSmart (JIBS)*, 7(1):38-51. <https://doi.org/10.30872/jibs.v1i1.423>
- Noverita, A., Darliana, E. 2024. Pendidikan lingkungan hidup untuk meningkatkan ecoliteracy siswa. *Jurnal Ilmiah Kanderang Tingang*, 15(1):29-39. <https://doi.org/10.37304/jikt.v15i1.302>
- Nurhasanah, S. (2024). Peran Mahasiswa Sebagai Pilar Integritas Dalam Gerakan Anti Korupsi Di Lingkungan Kampus Dan Masyarakat. *JPM: Jurnal Pengabdian Masyarakat*, 4(2) :128-136. <https://doi.org/10.47065/jpm.v4i2.1265>
- Olsson, D., Gericke, N., & Boeve-de Pauw, J. 2022. The effectiveness of education for sustainable development revisited – a longitudinal study on secondary students' action competence for sustainability. *Environmental Education Research*, 28(3):405-429. <https://doi.org/10.1080/13504622.2022.2033170>

- Putri, W., Restya, D., Zainab, S., Maisyarah, S., & Alfarizy, R. 2024. Aksiologiya : jurnal pengabdian kepada masyarakat dari eco-masjid menuju green campus: transformasi kesadaran lingkungan melalui peran strategis masjid from eco-mosque to green campus: *Transforming Environmental Awareness through the Strategic Role of M.* 8(4). <https://doi.org/10.30651/aks.v8i4.23187>
- Priatna, A. 2020. Manajemen Sekolah Adiwiyata (Green School). *Jurnal Soshum Insentif*, 3(2):37–43. <https://doi.org/10.36787/jsi.v3i1.214>
- Rahayu, I., Suwarna, A.I., Wahyudi, E., Asfahani, A., & Jamin, F.S. 2024. Pendidikan lingkungan hidup dengan membentuk kesadaran lingkungan dan tanggung jawab sosial di kalangan pelajar. *Global Education Journal*, 2(2):101–110. <https://doi.org/10.59525/gej.v2i2.344>
- Rezeki, T.I. Irwan, Wahyudin, R., Sagala, Rabukit, & Helman, M. 2022. Jurnal abdimas maduma. *Jurnal Pengabdian Kepada Masyarakat*, 1(2):14–20. <https://doi.org/10.52622/jam>
- Rustamana, A., Sahl, H.K., Ardianti, D., Hisyam, A., Solihin, S., Sultan, U., & Tirtayasa, A. 2024. Penelitian dan pengembangan (research & development) dalam pendidikan. *Jurnal Bima: Pusat Publikasi Ilmu Pendidikan Bahasa Dan Sastra*, 2(3): 60–69. <https://doi.org/10.61132/bima.v2i3.1014>
- Saputra, A., Rahmawan, Y.K., & Hidayat, M.T. 2023. Menumbuhkan sikap kepedulian siswa terhadap lingkungan melalui kegiatan penghijauan di Mts Muhammadiyah 5 Tukulrejo. *EJOIN: Jurnal Pengabdian Masyarakat*, 1(8):809–818. <https://doi.org/10.55681/ejoin.v1i8.1403>
- Singh-Pillay, A. 2023. Pre-service teachers' experience of learning about sustainability in technology education in south africa. *Sustainability*, 15(3):2149. <https://doi.org/10.3390/su15032149>
- Sukran, C.P.A., & Huda, I. 2023. Pengembangan aplikasi pembelajaran online dengan metode gamifikasi berbasis web. *Journal of Internet and Software Engineering*, 4(1): 6–11. <https://doi.org/10.22146/jise.v4i1.2456>
- Susilo, A., & Sarkowi, S. 2018. Peran guru sejarah abad 21 dalam menghadapi tantangan arus globalisasi. *Historia: Jurnal Pendidik Dan Peneliti Sejarah*, 2(1):43. <https://doi.org/10.17509/historia.v2i1.11206>
- Wijayanto, G., Mu'min, H., Waangsir, F.W., & Ardhiansyah, A. 2024. The effect of environmental education, consumer awareness, and environmentally friendly practices on plastic waste reduction in indonesia. *West Science Social and Humanities Studies*, 2(03): 401–411. <https://doi.org/10.58812/wsshs.v2i03.708>
- Windarto, W., & Martini, M. 2021. Empowering cibogo villagers, Kabupaten Tangerang, through educational and envirotnmental program. *Icccd*, 3(1):347–350. Angela, F. (2023). Ecotourism Development Strategy to Support Tahai Lake Nature Conservation. *JIM: Jurnal Ilmiah Mahasiswa Pendidikan Sejarah*, 8(3), 984–993. <http://jim.unsyiah.ac.id/sejarah/mm>
- Anafi, K., Wiryokusumo, I., & Leksono, I.P. (2021). Development of Addie Model Learning Media Using Unity 3D Software. *Jurnal Education and Development*, 9(4), 433–438. <https://www.neliti.com/publications/562409/>
- Aydin, A., Gürsoy, A., & Karal, H. (2023). Mobile Care App Development Process: Using the ADDIE Model to Manage Symptoms After Breast Cancer Surgery (Step 1). *Discover Oncology*, 14(1), 1–10. <https://doi.org/10.1007/s12672-023-00676-5>
- Azis, A. (2019). Conservation Psychology Study For Human Resource Development Through the go Green Program (A Case Study on Students Residing in UNNES

- Dormitories). *Jurnal Psikologi Ilmiah*, 7(1), 83–90. <https://doi.org/10.23887/jppsh.v6i2.50493>
- Bagaskar, F.R, Pratama, A., Armayoga, B., & Murtadho, A,. (2025). A Study on the Impact of Green Campus on Students' Environmental Awareness at UIN Raden Intan Lampung. *Journal of Basic Education Science*, 10(3), 42–64. <https://doi.org/10.23969/jp.v9i04.21558>
- Borrelle, S.B., Ringma, J., Law, K.L., Monnahan, C.C., Lebreton, L., McGivern, A., Murphy, E., Jambeck, J., Leonard, G.H., Hilleary, M.A., Eriksen, M., Possingham, H.P., De Frond, H., Gerber, L.R., Polidoro, B., Tahir, A., Bernard, M., Mallos, N., Barnes, M., & Rochman, C.M. (2020). Predicted Growth in Plastic Waste Exceeds Efforts to Mitigate Plastic Pollution. *A Science Partner Journal*, 369(6510), 1515–1518. <https://doi.org/10.1126/science.aba3656>
- Chan, F., Kurniawan, R., Oktavia, A., Dewi, C., Sari, A., Khairadi, P., & Piolita, S. (2019). Environmental Awareness Movement at Adi Widya Elementary School. *Jurnal Pendidikan Dasar*, 4(2), 190. <https://doi.org/10.25078/aw.v4i2.1126>
- Damayanti, D., Saputri, D. R., Septian, D., Marpaung, S., Yusupandi, F., Sanjaya, A., Simbolon, Y.M., Asmarani, W., Ulfa, M., & Wu, H. (2022). Current Prospects for Plastic Waste Treatment. *Journal Polymers*, 14(3133), 3–29. <https://doi.org/10.3390/polym14153133>
- Dewi, K.H. (2023). Indonesian Women and Local Politics. *US Press, 2015. JSTOR*, 1(4), 108–140. <https://doi.org/10.2307/j.ctv1nth4c.13>
- Dias, A., Revalina, N., Avrilia, D., Stevanie, F., Aurelly, F., & Irawan, B. (2024). Efforts to Preserve the Environment By Reducing Plastic Waste at the Faculty of Mathematics and Natural Sciences, Semarang University. *Jurnal Majemuk*, 3(2), 304–317. <http://jurnalilmiah.org/journal/index.php/majemuk>
- Dzamtoska-Zdravkovska, S., & Haque, M.I. (2025). The Influence of Digital Media on Climate Change Awareness, Action, and Perceived Barriers Among UAE University Students. *International Journal of Education and Sustainability*, 11(17), 2335–2350. <https://doi.org/10.64252/50qt6x84>
- Erwinsyah, E. (2022). Environmental Knowledge, Attitudes, and Practices for Behavior Change of University Students: The Case of Indonesia. *Journal of STEAM Education*, 5(2), 181–192. <https://doi.org/10.55290/steam.1075516>
- Eroğlu, E., Dev, D., & Dalgın, T. (2025). Exploring the Moderating Role of University Environmental Performance in Shaping Students' Environmental Awareness and Behaviors. *International Journal of Sustainability in Higher Education*, 17(2), 107–120. <https://doi.org/10.1108/IJSHE-05-2024-0323>
- Fauzi, M.F., & Nugrahani, H.S.D. (2023). Motives of Environmental Coverages By North European Mass Media: The Role of Three Nordic Countries on Combating Plastic Waste. *RSF Conference Series: Business, Management and Social Sciences*, 3(3), 38–45. <https://doi.org/10.31098/bmss.v3i3.689>
- Gabriella, D.A., & Sugiarto, A. (2020). Awareness and Environmentally Friendly Behavior of Students on Campus. *Jurnal Ilmu Sosial Dan Humaniora*, 9(2), 263–275. <https://doi.org/10.23887/jish-undiksha.v9i2.21061>
- Handoyo, B., Astina, I.K., & Mkumbachi, R.L. (2021). Students' Environmental Awareness and Pro-Environmental Behaviour: Preliminary Study of Geography Students at University Of Malang. *IOP Conference Series: Earth and Environmental Science*, 683(1), 12049–12066. <https://citeus.um.ac.id/jpg/vol25/iss2/6>

- Hajj-Hassan, M., Chaker, R., & Cederqvist, A.M. (2024). Environmental Education: A Systematic Review on The Use of Digital Tools for Fostering Sustainability Awareness. *Sustainability Journal*, 16(9), 3733-3748. <https://doi.org/10.3390/su16093733>
- Hurulean., E.A., & Sugiyanto. (2022). Community Participation in Waste Management as A Mediation of the Effect of Realigy Understanding on Environmental Cleanliness in Your District, Dogiyai Regency, Papua. *International Journal of Social Science*, 1(5), 757-766. <https://doi.org/10.53625/ijss.v1i5.1320>
- Irhas, M.I., Sugandini, D., Sukarno, A., Kundarto, M., Arundati, R., Berliana, N., Dari, D., & Klaster, H. (2020). Pro-Environmental Behavior in Students. *Yogyakarta : Zahira Publishing*.
- Islamiati, D.F., & Saputra, P.P. (2021). Analysis of the Green Lifestyle Trend Phenomenon Among Students at Bangka Belitung University. *Jurnal Studi Inovasi*, 1(2), 30-38. <https://doi.org/10.52000/jsi.v1i2.22>
- Jasmalinda. (2021). The Influence of Brand Image and Product Quality on Consumer Purchasing Decisions for Yamaha Motorcycles in Padang Pariaman Regency. *Jurnal Inovasi Penelitian*, 1(10):2199-2205. <https://doi.org/10.47492/jip.v1i10.422>
- Jayadinata, A.K., Muqodas, I., & Ardiyanti, D. (2024). Environmental Awareness of Prospective Teachers As a Character Value of Care for the Environment. *Jurnal Konseling Dan Pendidikan*, 12(2), 12-24. <https://doi.org/10.29210/1112000>
- Kartadireja, W.N. (2024). The Dynamics of Knowledge, Awareness, and Students' Public Speaking Skills in the Context of Environmental Cleanliness. *Jurnal Onoma*, 10(2), 1347-1360. <https://doi.org/10.30605/onoma.v10i2.3310>
- Khaerani, T.R. (2021). Innovation in Plastic Waste Reduction Policies in Balikpapan City. *Moderat: Jurnal Ilmu Pemerintahan*, 7(3), 556-569. <https://ojs.unigal.ac.id/index.php/modrat/article/download/2486/1893/8709>
- Khalifé, M., Chaker, R., & El Hage, H. (2022). Environmental Education and Digital Solutions: An Analysis of the Lebanese Context's Existing and Possible Digital Actions. *Frontiers in Education*, 7(4), 322-338. <https://doi.org/10.3389/feduc.2022.943056>
- Khalifé, E., Lhoste, É., & Venturini, T. (2022). Digital Innovation in Environmental Education: Overcoming the Limitations of Conventional Methods. *Environmental Education Research*, 11(2), 726-730. <https://doi.org/10.18421/TEM112-28>
- Lasaiba, I. (2023). Raising Ecological Awareness: A Biological Approach to Sustainability Education. *Jurnal Jendela Pengetahuan*, 16(2), 143-163. <https://ojs3.unpatti.ac.id/index.php/jp/article/view/10206>
- Ma'ruf, M., Surya, S., & Apriliany, P.D. (2016). Knowledge, Attitudes and Behavior of University Students Towards Environmental Issues in Indonesia. *Sains Humanika*, 8(2), 331-343. <https://doi.org/10.11113/sh.v8n1-2.836>
- Macheca, A.D., Mutuma, B., Adalima, J.L., Midheme, E., Lucas, L.H.M., Ochanda, V. K., & Mhlanga, S. D. (2024). Perspectives on Plastic Waste Management: Challenges and Possible Solutions to Ensure Its Sustainable Use. *Recycling*, 9(5), 1132-1143. <https://doi.org/10.3390/recycling9050077>
- Mahanta, B. (2023). Environmental Awareness Among Higher Education Students. *International Journal For Multidisciplinary Research*, 5(5), 243-255. <https://doi.org/10.36948/ijfmr.2023.v05i05.7040>
- Malik, R., & Sharma, A. (2022). Investigating Role of Community College and Student Responses Towards Awareness on Electric Vehicles As A Solution to Environmental

- Problems. *International Journal of Health Sciences*, 6(3), 2632–2648. <https://doi.org/10.53730/ijhs.v6ns8.12684>
- Mambetnizayov, M. (2021). Wordpress Opportunities in Creating Educational Sites. *Theoretical and Empirical Scientific Research*, 1(2), 204–205. <https://doi.org/10.36074/logos-28.05.2021.v1.62>
- Meika, R.D.S., & Putra, E.D. (2021). The Role of Teachers in Shaping the Character of Students who Care About the Environment at the Adiwiyata School at Mimbar Ilmu Elementary School, *Ejournal Undiksha*, 26(3), 346–355. <https://doi.org/10.23887/mi.v26i3.39617>
- Mkumbachi, R.L., Astina, I.K., & Handoyo, B. (2024). Environmental Awareness and Pro-Environmental Behavior: A Case of University Students in Malang City. *Jurnal Pendidikan Geografi: Kajian, Teori, Dan Praktek Dalam Bidang Pendidikan Dan Ilmu Geografi*, 25(2), 6–17. <https://doi.org/10.17977/um017v25i22020p161>
- Moridu, I., Melinda, P.A., Sidik, F.R., & Asfahani. (2023). Environmental Community Programs to Inspire Collective Sustainability Education Through Green Action. *Communnity Development Journal*, 4(4), 7121–7128. <https://journal.universitaspahlawan.ac.id/index.php/cdj/article/view/18699>
- Nasution, R. (2021). Analysis of Environmental Literacy Levels of FKIP Students at Mulawarman University Using NELA (National Environmental Literacy Assessment) Score Transformation. *Jurnal Ilmiah BioSmart (JIBS)*, 7(1), 38–51. <https://doi.org/10.30872/jibs.v1i1.423>
- Noverita, A., Darliana, E. (2024). Environmental Education to Improve Students' Ecoliteracy. *Jurnal Ilmiah Kanderang Tingang*, 15(1), 29–39. <https://doi.org/10.37304/jikt.v15i1.302>
- Olsson, D., Gericke, N., & Boeve-de Pauw, J. (2022). The Effectiveness of Education for Sustainable Development Revisited – A Longitudinal Study on Secondary Students' Action Competence for Sustainability. *Environmental Education Research*, 28(3), 405–429. <https://doi.org/10.1080/13504622.2022.2033170>
- Putri, W., Restya, D., Zainab, S., Maisyarah, S., & Alfarizy, R. (2024). From Eco-Mosque to Green Campus: Transforming Environmental Awareness Through the Strategic Role of M. *Aksiologi: Jurnal Pengabdian Kepada Masyarakat*, 8(4), 570–579. <https://doi.org/10.30651/aks.v8i4.23187>
- Priatna, A. (2020). Adiwiyata School Management (Green School). *Jurnal Soshum Insentif*, 3(2), 37–43. <https://doi.org/10.36787/jsi.v3i1.214>
- Rahayu, I., Suwarna, A.I., Wahyudi, E., Asfahani, A., & Jamin, F.S. (2024). Environmental Education By Forming Environmental Awareness and Social Responsibility Among Students. *Global Education Journal*, 2(2), 101–110. <https://doi.org/10.59525/gej.v2i2.344>
- Saputra, A., Rahmawan, Y.K., & Hidayat, M.T. (2023). Cultivating Students' Concern for the Environment Through Greening Activities at Mts Muhammadiyah 5 Tukulrejo. *EJOIN: Jurnal Pengabdian Masyarakat*, 1(8), 809–818. <https://doi.org/10.55681/ejoin.v1i8.1403>
- Singh-Pillay, A. (2023). Pre-Service Teachers' Experience of Learning About Sustainability in Technology Education in South Africa. *Sustainability*, 15(3), 2149–2162. <https://doi.org/10.3390/su15032149>
- Wijayanto, G., Mu'min, H., Waangsir, F.W., & Ardhiyansyah, A. (2024). The Effect of Environmental Education, Consumer Awareness, and Environmentally Friendly

- Practices on Plastic Waste Reduction in Indonesia. *West Science Social and Humanities Studies*, 2(3), 401–411. <https://doi.org/10.58812/wsshs.v2i03.708>
- Windarto, W., & Martini, M. (2021). Empowering Cibogo Villagers, Kabupaten Tangerang, Through Educational and Environmental Program. *ICCD*, 3(1), 347–350. <https://doi.org/10.33068/iccd.vol3.iss1.374>
- Yunita, Y., & Elihami, E. (2021). Problem Solving in Distance Learning with E-Learning Media: Discourse Through Problem Solving in the Era of the Covid-19 Pandemic. *Jurnal Komunikasi Pendidikan*, 2(1), 133–146. <https://doi.org/10.32585/jurnalkomdik.v7i1.2209>
- Yusup, F. (2021). Environmental Literacy Profile of Prospective Science Teacher Students. *Quantum: Jurnal Inovasi Pendidikan Sains*, 12(1), 128–140. <https://doi.org/10.20527/quantum.v12i1.10098>
- Yunita, Y., & Elihami, E. 2021. Problem solving pembelajaran jarak jauh dengan media e- learning: diskursus melalui problem solving di era pandemik covid-19, *Jurnal Komunikasi Pendidikan*, 2(1): 133–146. <https://doi.org/10.32585/jurnalkomdik.v7i1.2209>
- Yusup, F. 2021. Profil literasi lingkungan mahasiswa calon guru ipa. *Quantum: Jurnal Inovasi Pendidikan Sains*, 12(1):128. <https://doi.org/10.20527/quantum.v12i1.10098>