IJIS Edu : Indonesian J. Integr. Sci. Education, 7 (2) 2025

Volume 7 Issue 2 , July 2025
P-ISSN: 2655-2388, E-ISSN: 2655-2450

Project-Based Environmental Science Learning to Create Environmental Care Character

Siti Roudlotul Hikamah[1*], Hariyanto Hariyanto[2], Slamet Hariyadi[3]

[1] *Biology Education Study Program, Universitas Islam Jember, Indonesia.*
[2] *Early Childhood Education Study Program, Universitas PGRI Argopuro Jember, Indonesia*
[3]*Biology Education Study Program, Universitas Jember, Indonesia*

Corresponding E-mail: sitihikamah@yahoo.com

Abstract: This study aims to realize the character of students who care about the environment. The type of research used is Research and Development (R&D) by adapting the development model from Plomp through 3 stages, namely: 1) analysis); 2) design and development of prototypes; 3) evaluation. The research sample consisted of 23 students. The results of the product evaluation, especially the character values obtained after completing the project activities, yielded a character value of 77.04, which falls into the outstanding category. Meanwhile, recycling waste into valuable products yielded an average value of 79.46, placing it in the outstanding category. These results indicate that project-based learning is very suitable for developing the character values of students who care about the environment.

Keywords: Environment science, Environmental care character, Learning, Project

How to cite this article:

Hikamah, S., & Hariyanto, H. (2025). Project-Based Environmental Science Learning to Create Environmental Care Character. *IJIS Edu : Indonesian Journal of Integrated Science Education, 7*(2). doi:http://dx.doi.org/10.29300/ijisedu.v7i2.7257

1. Introduction

Environmental science is one of the biological sciences that integrates various sciences, including chemistry, physics, geology, atmosphere, geography, and ecology. This science studies environmental problems and their solutions. An environmental problem that has yet to be resolved until now is the problem of waste, especially plastic waste. Plastic waste is a pollutant factor for the earth because it is difficult to decompose. Indonesia is the second largest contributor of plastic waste to the sea after China; this is revealed in the list of the top 10 countries in the world whose seas are polluted by plastic waste (Maskun et al., 2022; Northcoot, 2020; Tarigan, 2021).

If left unchecked, this plastic waste can cause various other problems, such as disturbing the natural landscape, disturbing decomposing microorganisms, causing a flood hazard, and can even cause toxic compounds (Hidayat et al., 2019). One solution that can be done to tackle plastic waste is to reduce, reuse, and recycle (3R) (Febriadi, 2019; Syaharuddin et al., 2020; Valentine, 2019). Reduce is an effort to reduce the amount of plastic waste by reducing the use of plastic (Solekah et al., 2022), such as replacing plastic wrap with paper wrap, replacing plastic wrap with containers that can be used repeatedly, and so on. Reuse is an effort to reuse plastic used before (Lamba et al., 2022), such as plastic bottles used for drinking water to place liquid detergent. Recycle is an effort to recycle plastic waste into products that are more useful and have economic value (Darus et al., 2020; Lamba et al., 2022; Northcoot, 2020; Syaharuddin et al., 2020; Valentine, 2019). In addition, it is essential to introduce plastic recycling products to the public to create a sustainable recycling market and industry (Soemadijo et al., 2022).

Products resulting from the recycling of plastic waste include chairs and bookshelves made from recycled used plastic bottles of mineral water filled with ecobrick plastic (Hikamah et al., 2024; Mamdudah et al., 2023; Sumiati et al., 2024); shopping bags come from recycled drinking water plastic cups; flower pots and tissue holders are from recycled drinking water plastic bottles; flower pots come from recycling used diapers. This recycling process can be carried out by students as students in collaboration with the community through Project-based learning.

The Indonesian government, through the Minister of Education and Culture (Kemendikbudristek), starting in 2022, will change the curriculum to become an independent curriculum. It is called Merdeka Learning Kampus Merdeka (MBKM) in higher education. The outline of the independent curriculum is teaching according to the student's ability level, organizing the implementation of learning, and the structure of the independent curriculum in each phase. Implementation of this curriculum through 4 steps, namely: 1) understand the outline of the independent curriculum; 2) understand the operational curriculum development of academic units in the independent curriculum; 3) understand learning and assessment; 4) understand the development of a project to strengthen the Pancasila student profile (Satria et al., 2022a).

The Pancasila student profile is the character and abilities built-in in daily life. It is lived in each student through the culture of the education unit, intra-curricular learning, and projects to strengthen Pancasila student profiles and extracurriculars.

The Pancasila Student Profile Strengthening Project (P5) consists of 7 themes, namely: 1) sustainable lifestyles: 2) local wisdom; 3) Unity in Diversity: 4) waking up the body and soul, 5) democratic voice, 6) engineering, and technology: 7) entrepreneurship. The principles of the Pancasila student profile consist of 1) holistic; 2) contextual; 3) centred on learners; 4) explorative. The dimensions of the Pancasila student profile consist of: 1) having faith, fearing God Almighty, and having noble character; 2) global diversity; 3 mutual assistance; 4) independent; 5) critical reasoning; 6) creative (Aditomo, 2022; Hikamah et al., 2025; Satria et al., 2022b).

Based on the Decree of the Ministry of Education and Culture No. 009/H/KR/2022 concerning the Dimensions, Elements, and Sub-elements of the Pancasila Student Profile in the Independent Curriculum, at point B.1.d states that Pancasila Students embody their noble character in responsibility, compassion, and caring for the surrounding natural environment. This awareness is the basis for feeling yourself implementing a lifestyle that cares about the environment so that it actively contributes to preserving the environment (Aditomo, 2022). The most effective way to increase environmental awareness among students, especially in handling the problem of plastic waste, is in an educational environment (Situmorang et al., 2020); the character of caring for the environment can be obtained through thematic learning (Ramli et al., 2022). The novelty of this research lies in integrating environmental science learning with waste management projects for students enrolled in this course, aiming to foster an environmental stewardship mindset.

The discrepancy that has occurred so far is that the management of plastic waste in Jember Regency has not been optimal, with the hope that the Ministry of Education and Culture will that in this MBKM, students can apply a lifestyle that cares for the environment to maintain its sustainability. Therefore, the solution taken is to carry out learning in courses on environmental science using projects to realize the character of caring for the environment.

2. Method

The type of research used is Research and Development (R&D) using the development model from Plomp; this research was carried out through 3 stages, namely: 1) analysis); 2) design and develop prototypes; 3) evaluation (Plomp, 2013). In the analysis phase, researchers observed several Temporary Waste Disposal Sites (TPSS) and Final Waste Disposal Sites (TPSA) locations in the Jember Regency. In addition, researchers distributed environmental care questionnaires to students taking environmental science courses before and after implementing the project. At the design and development prototype stage, students carry out the project by forming groups of 23 students into six groups, each consisting of 4 people, except for one group of 3. Each group carries out a waste management project, both organic and inorganic waste, especially plastic waste. Each group carries out activities based on the direction of the author as a supporting lecturer; these activities include 1) determining goals; 2) designing activities; 3) carrying out activities according to plan; 4) evaluating and improvement of activities; 5) writing down all the activities that

Online ISSN 2655-2450 | Print ISSN 2655-2388

have been carried out. The five stages of this activity are continuously consulted and receive directions from researchers to monitor all activities well.

Group 1 recycled eco brick plastic waste into bookcases; 2) group 2 carried out 3R activities to prevent flood hazards; 3) group 3 carried out 3R activities in the campus environment; 4) group 4 recycled used diapers into flower pots; 5) group 5 recycles household plastic waste into flower pots and tissue paper; 6) group 6 recycles tofu dregs into a combination of catfish (*Clarias* sp.) feed. The projects produced by each group are then written into a manuscript and submitted to a journal or entered into a fair competition. At the evaluation stage, the researcher evaluates the results of student projects through 1) the products produced, 2) writing the results of activities as output, and 3) a questionnaire related to the character of caring for the environment.

The population of this study was students of the Biology Education Study Program at private universities in Jember City. The sample for this research was students taking the Environmental Science course in the Odd Semester of the 2022/2023 Academic Year with a total sample of 23 students. The sample was selected based on the problems that occurred in Jember Regency, that there is still a lot of plastic waste piled up in TPSS, TPSA, in the river. In addition, based on the results of a needs analysis through a questionnaire regarding the character of caring for the environment for students taking environmental science courses, the results of the needs analysis revealed that 23 students: 1 student in the excellent category; 7 students in the category need improvement; 15 students in the category below expectations.

The instruments used in this study were divided into 3, consisting of 1) instruments for conducting needs analysis: observation sheets and questionnaires. Observation sheets were used to obtain data about the condition of waste in several TPSS and TPSA in Jember Regency, while questionnaires were used to determine the character of caring for the environment; 2) instruments to determine the progress of project design and develop prototypes, namely using observation sheets; 3) instruments for evaluating, namely observation sheets for evaluating products and output, and questionnaires for evaluating environmental care characters.

The observation sheet used when carrying out the needs analysis was obtained from adaptation and adopted from the TPS 3R Technical Guidelines by the Directorate General of Cipta Karya (Hartoyo, 2017). The environmental care character questionnaire consists of 8 indicators; each indicator has five statements, and so there are 40 statements adapted from this questionnaire (Mualifah, 2019; Seandrio, 2019). The project evaluation observation sheet is in the form of recycling waste into usable products; the observation sheet consists of 4 stages, four stages consist of 23 descriptions; this observation sheet is adapted from (Satria et al., 2022a); 4) the output assessment observation sheet, namely the product in the form of a manuscript consisting of 9 descriptions, this observation sheet was adapted from (Satria et al., 2022a).

Data collection at the needs analysis stage

Observational data on TPSS and TPSA are evaluated using Table 1.

Table 1. TPSS and TPSA Evaluation Instruments Around PTS Campuses in Jember

No	Aspects/Criteria	Indicator	Parameter	Indicator Value	Value/Aspect	Quality	Relative Value
1	Product settings that support	2 Indicator	1, 3, 5 (each indicator)	The value of the corresponding indicator	Number of indicator values	5%	Aspect Value × quality
2	Technical - technology	6 Indicator	1, 3, 5 (each indicator)	The value of the corresponding indicator	Number of indicator values	30%	Aspect Value × quality
3	Management institution	6 Indicator	1, 3, 5 (each indicator)	The value of the corresponding indicator	Number of indicator values	30%	Aspect Value × quality
4	Finance	3 Indicator	1, 3, 5 (each indicator)	The value of the corresponding indicator	Number of indicator values	15%	Aspect Value × quality
5	Participation	4 Indicator	1, 3, 5 (each indicator)	The value of the corresponding indicator	Number of indicator values	20%	Aspect Value × quality

Source: Adaptation and adoption (Hartoyo, 2017).

The TPSS and TPSA assessment categories around the Private Higher Education (PTS) campuses in Jember are based on Table 2.

Table 2. TPSS and TPSA assesment categories

Total	Category
>19,0	Good
14,3 < N ≤ 19,0	Currently
9,5 < N ≤ 14,3	Not enough
< 9,9	Bad

Source (Hartoyo, 2017).

The character of caring for the environment of students was analyzed using a questionnaire. The environmental care character instrument grid is presented in Table 3.

Table 3. Grid of Environmental Care Character Instruments

Values	Description	Indicator	Items
Environmental care attitude	Attitudes and actions that always seek to prevent damage to the surrounding natural environment.	The habit of maintaining cleanliness and environmental sustainability wherever they are	1-5
		Maintain the classroom environment	6-10
		Make it a habit to dispose of trash according to its kind	11-15
		Tree planting	16-20
	Make efforts to repair environmental damage that has occurred.	Reducing the use of plastic and anything containing plastic	21-25
		Reusing used plastic	26-30
		Recycle plastic waste	31-35
		Carry out community service activities to repair environmental damage	36-40

Online ISSN 2655-2450 | Print ISSN 2655-2388

Source: Adaptation and collaboration (Fadilla et al., 2022; Mualifah, 2019; Muharlisiani et al., 2021; Seandrio, 2019).

The assessment criteria for each environmental care character item are assessed using Table 4.

Table 4. Environmental Care Character Scores

Indicator	Skor
Always	5
Often	4
Enough	3
Not enough	2
Very little or nothing	1

Adaptation from (Singarimbun et al., 2006).

The environmental care character value is calculated using the percentage formula as follows:

Environmental Care Character Value = $\frac{\sum \text{Score obtained}}{\sum \text{maximum score}}$ 100 (Akbar, 2013).

The category level of students' environmental care character is calculated using Table 5.

Table 5. Categories of Environmental Care Character Levels

Renting nilai (%)	Category
81,25 ≤x≤100	Exceeded expectations
62,5≤x<8,25	Satisfying
43,75≤x<62,5	Needs Improvement
25≤x<43,75	Below expectations

Adapted from (Akbar, 2013).

Data collection at the design and development prototype stage

The data from the design and develop a prototype, namely recycling waste into useful products, in this activity, is evaluated using Table 6.

Table 6. Design and Development of Evaluation Instruments to Recycle Waste into Useful Products

Stage	Description
Planning	Topics, objectives, tools and materials, work steps, schedule of activities, list of activities by the objectives
Implementation	Accuracy in using tools and materials, data obtained according to purpose, the accuracy of work steps according to planning, activities according to a predetermined schedule, and data recorded neatly, clearly and thoroughly.
Data processing	Data is classified, data is processed according to the purpose
Data Presentation	the accuracy of the collection schedule, submitting project results

Source adapted from (Satria et al., 2022b).

The score of each evaluation item is assessed using Table 7

Table 7. Design and Develop Score Recycle Waste into Useful Products

Indicator	Score
Perfect fit	5
In accordance	4
Quite appropriate	3
Not suitable	2
Very less or inappropriate	1

Adaptation from (Singarimbun et al., 2006).

The design and development percentage values for recycling waste into valuable products are calculated using the percentage formula (Akbar, 2013), and the design and development categories for recycling waste into valuable products follow Table 5 (Akbar, 2013).

Data collection at the product evaluation stage

The results of recycling waste into valuable products, such as bookshelves, tissue boxes, flower pots and others, are written in a manuscript by each group. These results are evaluated using Table 8.

Table 8. The manuscript evaluation grid for each group

Stage	Description
Manuscript Writing (Product)	
	Manuscript title
	Manuscript outline writing
	Background writing
	Method Writing
	Results Writing
	Discussion Writing
	Complete manuscript
	Manuscript submitted to the Journal.
	Article published

The percentage value of manuscripts is calculated using the percentage formula (Akbar, 2013); the manuscript categories follow Table 5 (Akbar, 2013).

3. Result and Discussion

Observation results at the needs analysis stage

Observational data on TPSS and TPSA around the PTS campus in Jember are presented in Table 10.

Table 10. TPSS and TPSA Observation Results around the PTS campus in Jember

No	TPSS and TPSA locations	Nilai Relatif	Category
1	Campus environment	7,45	Bad
2	East of Campus	10,05	Not enough
3	North of Campus	9,85	Not enough
4	West side of campus	10	Not enough
5	South of Campus	10	Not enough
Average		**9,47**	**Not enough**

Online ISSN 2655-2450 | Print ISSN 2655-2388

Based on Table 10 above informs that 20% of the waste management at TPSS and TPSA around the PTS campus in Jember is terrible, and 80% is lacking. The character values of caring for the environment for students at this PTS before carrying out project activities are presented in Table 11.

Table 11. Student Environmental Care Character Values at PTS in Jember prior to Project Implementation

Number of respondents	Average Score Obtained	Max Score	Character Value	Category
23	80,83	200	40,41	Below expectations

Results in the Design and Develop Prototype Evaluation Stage

The results of recycling waste into valuable products; Group 1 recycled eco brick plastic waste into bookcases; Group 2 carried out 3R activities to prevent flood hazard; Group 3 conducted 3R activities in the campus environment; Group 4 recycled used diapers into flower pots; group 5 recycled household plastic waste into flower pots and tissue paper; Group 6 recycled tofu waste into a combination of catfish (*Clarias* sp.) feed. The recycling evaluation results for each group are presented in Table 12

Table 12. Evaluation Results of Recycling Waste into Useful Products

Group	Total score obtained	Maximum total score	Project Value	Category
1	114	120	95	Exceeded expectations
2	113	120	94,17	Exceeded expectations
3	72	120	60	Needs Improvement
4	112	120	93,33	Exceeded expectations
5	111	120	92,5	Exceeded expectations
6	66	120	55	Needs Improvement
Average	98	120	**81,67**	**Exceeded expectations**

Results in the Product Evaluation Stage

Caring for the Environment Character Value of Students after Carrying Out Project Activities. The value of the environmental care character of students at this PTS after carrying out Project activities, namely recycling waste into valuable products, is presented in Table 13.

Table 13. Character Values of Caring for the Environment of Students at PTS in Jember after Project Implementation (recycle waste into valuable products)

Number of respondents	Average Score Obtained	Max Score	Character Value	Category
23	158,91	200	79,46	**Satisfying**

Results at the Manuscript Evaluation Stage

All groups after recycling waste into valuable products; this activity is carried out together with the local community. Then they write down all the activities carried out in a manuscript. The results of the manuscript evaluation are presented in Table 14.

Table 14. Manuscript Evaluation Results for Each Group

Group	Total score obtained	Maximum total score	Project Value	Categories
1	44	45	97,78	Exceeded expectations
2	42	45	93,33	Exceeded expectations
3	19	45	42,22	Below expectations
4	41	45	91,11	Exceeded expectations
5	41	45	91,11	Exceeded expectations
6	21	45	46,67	Need Improvement
Average	**34,67**	**45**	**77,04**	**Satisfying**

Education and research involving students in waste management can increase student awareness of caring for the environment while increasing the circular economy in educational institutions (Lefebvre & Luo, 2020; Merewether et al., 2023). The circular economy is the integration of the concept of 3R waste management with the linear economy, namely green economy and green environment, which aims to create a sustainable life and economy (Darmastuti et al., 2021; Dwiningsih & Harahap, 2022; Kristianto et al., 2022; Purwanti, 2021; Trisyanti et al., 2022). An environmentally conscious character can create a healthy, positive, and friendly school environment. This is an ideal condition for the student learning process at school (Handayani et al., 2020).

The character of caring for the environment of students is created because of routine 3R management activities that are carried out daily (Wibowo et al., 2021). Therefore, it is necessary to emphasize the waste management paradigm through Environmental Education (PLH) to create an attitude of caring for the environment. Several Adiwiyata schools have succeeded in integrating monolithic environmental learning and integrated education, resulting in students' attitudes of caring for the environment that is better than those of students who do not participate in these activities (Istiqomah et al., 2020). One way that an elementary school has done this is by implementing a curriculum based on environmental care in improving character education in schools; the results obtained include students getting used to disposing of garbage in its place and, according to its type, repairing environmental damage that has occurred, and environmental sustainability can be maintained so that sustainable benefits are obtained (Oktarina & Nisa, 2021). A vocational high school has made teaching materials based on Science, Environment, Technology and Society (SETS), applied to the learning process of hazardous and toxic materials (B3) and non-hazardous and non-toxic materials, as well as B3 waste handling techniques to realize the character of caring for the environment (Hidayana & Rusmini, 2021). In other schools, character empowerment for caring for the environment is carried out through religious education (Fua et al., 2018; Mardhiah et al., 2021).

Another effort that can be used to realize the character of caring for the environment for students is through project-based learning. This has been done in several schools, including elementary schools in Lampung Province; project-based learning can foster the character of generosity, cooperation, and leadership (Arrasyid et al., 2022). The results of previous studies also inform that involving various parties in managing company waste can create environmentally friendly behaviour from all

Online ISSN 2655-2450 | Print ISSN 2655-2388

parties so that sustainable environmental care practices are obtained (Ardaniah, 2022). In addition, several research results inform that project-based learning is beneficial for, acquiring new biological knowledge related to the human immune system (Baptist et al., 2020), effective in learning material changes in the physical environment (Turyati et al., 2020), improve student writing achievement (Cahyaningrum & Widyantoro, 2020). Other benefits that project-based learning can foster student independence (Halimatusyadiyah et al., 2022) and improve 21st-century skills (Elvianasti et al., 2022), include critical thinking skills, problem-solving, metacognition, communication skills, collaboration, innovation and creation, as well as information literacy (Greenstein, 2012; Zubaidah, 2020).

The results of this study are in line with previous studies, which suggest that the Positive Character Cam project can improve environmental consciousness in high schools in Malang, Indonesia (Arent et al., 2020; Syahri et al., 2020). An environmentally conscious character can be developed through learning projects by planning, providing direction, motivating, offering guidance, implementing environmentally aware policies, and encouraging changes in student behaviour towards the environment (Khasana et al., 2023). Additionally, the internalisation of an environmentally conscious character can also be achieved through the Pancasila student profile strengthening project (Puspitasari et al., 2023). Character education is considered important because it can lead to moral degradation if not taught appropriately to students in school (Husen et al., 2022). Furthermore, this character needs to be applied in everyday life (Rosniwaty et al., 2024).

4. Conclusion

Garbage is an object the owner no longer uses; this waste is generally thrown away. Especially plastic waste takes up to hundreds of years to completely decompose. Therefore, it needs to be appropriately managed through reduce, reuse and recycle (3R) activities so that plastic waste does not pollute the environment. Efforts to realize the character of students who care about the environment are carried out through project-based learning. This project-based environmental science learning involves students directly carrying out 3R activities, especially recycling. The recycling project is being carried out by student groups and the community around plastic waste piled up or scattered around. They recycle plastic waste into products that can be utilized and have economic value. The results of the project activities foster the character of students who care about the character of caring for the environment.

References

Aditomo, A. (2022). *Keputusan Kepala Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, Riset, dan teknologi tentang Dimensi, Elemen, dan Subelemen Profil Pelajar Pncasila pada Kurikulum Merdeka* (pp. 1–38).

Akbar, S. (2013). *Instrumen Perangkat Pembelajaran* (Kedua). PT Remaja Rosdakarya.

Ardaniah, V. (2022). Building Sustainable Waste Management Based on Environmentally Friendly Behavior in Healthcare Industry: a Systematic Review. *Jurnal Riset Akuntansi Dan Bisnis Airlangga*, *7*(1), 1232–1244. https://doi.org/10.20473/jraba.v7i1.36179

Arent, E., Sumarmi, Utomo, D. H., & Ruja, I. N. (2020). Improving students' environmental care character through Positive Character Camp (PCC) program. *Journal for the Education of Gifted Young Scientists*, *8*(4), 1329–1343. https://doi.org/10.17478/jegys.771681

Arrasyid, A. K., Herpratiwi, H., & Yulianti, D. (2022). Instilling Positive Character Values through Project-Based Learning for Private Elementary School Students in Lampung Province, Indonesia. *Jurnal Pendidikan Progresif*, *12*(3), 1408–1422. https://doi.org/10.23960/jpp.v12.i3.202231

Baptist, K. j., Utami, D. N., Subali, B., & Aloysius, S. (2020). Effectiveness of Project-Based Learning and 5E Learning Cycle Instructional Models. *Jurnal Kependidikan*, *4*(1), 55–69. https://doi.org/10.21831/jk.v4i1.27107

Cahyaningrum, T., & Widyantoro, A. (2020). Effect of project-based learning and problem-based learning on the students' writing achievement. *LingTera*, *7*(1), 72–83. https://journal.uny.ac.id/index.php/ljtp/article/view/13700

Darmastuti, S., Cahyani, I. P., Afrimadona, A., & Ali, S. (2021). Pendekatan Circular Economy Dalam Pengelolaan Sampah Plastik di Karang Taruna Desa Baros, Kecamatan Baros, Kabupaten Serang. *Indonesian Journal of Society Engagement*, *1*(2), 1–18. https://doi.org/10.33753/ijse.v1i2.13

Darus, N., Tamimi, M., Tirawaty, S., Muchtazar, M., Trisyanti, D., Akib, R., Condorini, D., & Ranggi, K. (2020). an Overview of Plastic Waste Recycling in the Urban Areas of Java Island in Indonesia. *Journal of Environmental Science and Sustainable Development*, *3*(2), 402–415. https://doi.org/10.7454/jessd.v3i2.1073

Dwiningsih, N., & Harahap, L. (2022). Pengenalan Ekonomi Sirkular (Circular Economy) Bagi Masyarakat Umum. *Empowerment: Jurnal Pengabdian Masyarakat*, *1*(2), 135–141. https://info.trilogi.ac.id/repository/assets/uploads/MNJ/5c624-publikasi-penelitian-pkm.pdf

Elvianasti, M., Festiyed, Yerimadesi, Kartikawati, E., & Zulherman. (2022). Research Trends in PjBL (Project-Based Learning) at Indonesian Journal of Biology Education. *Jurnal Iqra' : Kajian Ilmu Pendidikan*, *7*(2), 105–119. https://doi.org/10.25217/ji.v7i2.2464

Fadilla, B., Lizmah, S. F., & Ritonga, N. C. (2022). Potensi Pemanfaatan Burung Hantu Tyto alba sebagai Predator Alami dalam Pengendalian Hama Tikus pada Tanaman Kelapa Sawit (Elaeis guineensis jaqc.) di Divisi II PT. SOCFINDO Seunagan. *Biofarm: Jurnal Ilmiah Pertanian*, *18*(2), 80. https://doi.org/10.31941/biofarm.v18i2.2283

Online ISSN 2655-2450 | Print ISSN 2655-2388

Febriadi, I. (2019). Pemanfaatan sampah organik dan anorganik untuk mendukung go green concept di sekolah. *Abdimas: Papua Journal of Community Service*, *1*(1), 32–39. https://ejournal.um-sorong.ac.id/index.php/pjcs/indexDOI:https://doi.org/10.33506/pjcs.v1i1.348.

Fua, J. L., Wekke, I. S., Sabara, Z., & Nurlila, R. U. (2018). Development of Environmental Care Attitude of Students through Religion Education Approach in Indonesia. *IOP Conference Series: Earth and Environmental Science*, *175*(1), 1–7. https://doi.org/10.1088/1755-1315/175/1/012229

Greenstein, L. (2012). *Assessing 21st Skill: A guide to evaluating mastery and authentic learning*.

Halimatusyadiyah, N., Anasya, S. W., & Pajri, A. (2022). The Effectiveness Of The Project Based Learning Model In The Independent Learning Curriculum. *Jurnal Kewarganegaraan*, *6*(2), 3. https://doi.org/10.31316/jk.v6i2.4021

Handayani, N., Hariri, H., Sowiyah, S., & Ridwan, R. (2020). The Shaping of the Student Character Caring for the School Environment through the Green School Movement in SMP Negeri 2 Adiluwih. *Journal of Physics: Conference Series*, *1655*(1), 1–11. https://doi.org/10.1088/1742-6596/1655/1/012115

Hartoyo, S. (2017). Petunjuk Teknis TPS 3R Tempat Pengolahan Sampah 3R. In *Kementerian Pekerjaan Umum dan Perumahan Rakyat Direktorat Jenderal Cipta karya* (p. 152). https://simantu.pu.go.id/personal/img-post/3674064602000006/post/20230821112743__F__1._Kebijakan_Pembangunan_dan_Pengelolaan_TPS_3R.pdf

Hidayana, M. Z., & Rusmini, R. (2021). Development of Teaching Materials for Handling Hazardous and Non Hazardous Waste Based on Sets. *JCER (Journal of Chemistry Education Research)*, *5*(2), 51–60. https://doi.org/10.26740/jcer.v5n2.p51-60

Hidayat, Y. A., Kiranamahsa, S., & Zamal, M. A. (2019). A study of plastic waste management effectiveness in Indonesia industries. *AIMS Energy*, *7*(3), 350–370. https://doi.org/10.3934/ENERGY.2019.3.350

Hikamah, S. R., Hariyadi, S., & Siskawati, F. S. (2025). Optimization of the Pancasila student profile character through the local wisdom project of Hylocereus sp . Plants. *Edubiotik: Jurnal Pendidikan, Biologi Dan Terapan*, *10*(01), 1–10. https://doi.org/10.33503/ebio.v10i01.5

Hikamah, S. R., Rulloh, R., Nurkholisoh, D., & Sholihin, T. (2024). Project for recycle bubble wrap , used plastic and patchwork into sitting pillows : Environmental education efforts. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *10*(2), 666–672. https://doi.org/10.22219/jpbi.v10i2.32219

Husen, A., Casmana, A. R., Hasan, R. O., & Erfinda, Y. (2022). Implementation of Teaching Character Education, Particularly in Environmental Care Value, in Labschool Jakarta. *Journal of Social Studies Education Research*, *13*(4), 225–249. https://files.eric.ed.gov/fulltext/EJ1375619.pdf

Istiqomah, I., Suwondo, S., & Firdaus, L. . (2020). Environmental Education in Forming Attitudes of Environmental Care for Students. *Journal of Educational Sciences*, *4*(1), 200–211. https://doi.org/10.31258/jes.4.1.p.200-211

Khasana, N., Pambudi, D. I., & Masaei, N. (2023). Implementing Effective Strategies

to Foster Environmental Care Character among Students. *International Journal of Learning Reformation in Elementary Education*, 2(02), 86–94. https://doi.org/10.56741/ijlree.v2i02.312

Kristianto, A. H., Siahaan, S. V. br, & Vuspitasari, B. K. (2022). Studi Kasus Desa Sungai Duri Kabupaten Bengkayang. *Jurnal Maneksi*, *11*(1), 231–236. 10.31959/jm.v11i1.1069

Lamba, P., Kaur, D. P., Raj, S., & Sorout, J. (2022). Recycling/reuse of plastic waste as construction material for sustainable development: a review. *Environmental Science and Pollution Research*, *29*(57), 86156–86179. https://doi.org/10.1007/s11356-021-16980-y

Lefebvre, O., & Luo, J. (2020). An authentic learning approach to engage solid waste engineering students. *Procedia Computer Science*, *172*(2019), 748–759. https://doi.org/10.1016/j.procs.2020.05.107

Mamdudah, E. A., Kustini, S. M., Alwi, K. S. M., Hikamah, S. R., & Ichsan, M. T. (2023). Pemanfaatan Limbah Plastik Ecobrick Menjadi Rak Buku. *Dedication: Jurnal Pengabdian Masyarakat*, *7*(1), 21–30. https://doi.org/10.31537/dedication.v7i1.1022

Mardhiah, I., Amaliyah, Hakam, A., & Hadiyanto, A. (2021). Developing environmental care attitudes among college students through islamic education (IRE) learning with a humanist-contextual approach. *IOP Conference Series: Earth and Environmental Science*, *743*(1), 1–10. https://doi.org/10.1088/1755-1315/743/1/012004

Maskun, Assidiq, H., Bachril, S. N., & Mukarramah, N. H. Al. (2022). Tinjauan Normatif Penerapan Prinsip Tanggung Jawab Produsen Dalam Pengaturan Tata Kelola Sampah Plastik Di Indonesia Normative Review of the Implementation of Producer Responsibility Principle in Regulation of Plastic Waste Management in Indonesia. *Bina Hukum Lingkungan*, *6*(2). http://dx.doi.org/10.24970/bhl.v6i2.159

Merewether, J., Blaise, M., Pitchford, K., & Giamminuti, S. (2023). Unsettling "reduce-reuse-recycle": the provocation of wastepaper and "discarding well." *The Journal of Environmental Education*, *54*(3), 199–213. https://doi.org/• https://doi.org/10.1080/00958964.2023.2179585

Mualifah, Y. (2019). *Studi Tempat Pengolahan Sampah Reduce, Reuse, Recycle (TPS 3R) di Dusun Salakan, Potorono, Banguntapan, Bantul*. Poltekkes Kemenkes Yogyakarta. http://eprints.poltekkesjogja.ac.id/id/eprint/1925

Muharlisiani, L. T., Soesatyo, Y., Khamidi, A., Hariyati, N., Bariroh, S., Noerhartati, E., Sugiono, J., & Jatiningrum, C. (2021). Environmental Caring Through Character Education in Vocational School. *IJEBD (International Journal of Enterprenewrship and Business Development)*, *4*(1), 41–46. https://jurnal.narotama.ac.id/index.php/ijebd/article/view/1224

Northcoot, M. S. (2020). Rubbish, Recycling and Religion: Indonesia's Plastic Waste Crisis and the Case of Rumah Kompos in Ubud, Bali. *International Journal of Interreligious and Intercultural Studies (IJIIS)*, *3*(1), 1–19. https://doi.org/10.32795/ijiis.vol3.iss1.2020.680

Oktarina, E., & Nisa, A. F. (2021). Development of Environmental Care-Based Curriculum in Improving Character Education in Elementary Schools. *Jhss (Journal of Humanities and Social Studies)*, *5*(2), 126–130.

Online ISSN 2655-2450 | Print ISSN 2655-2388

https://doi.org/10.33751/jhss.v5i2.3713

Plomp, T. (2013). Preparing education for the information society : the need for new knowledge and skills. *Int. J. Social Media and Interactive Learning Environments*, *1*(1), 3–18. 10.1504/IJSMILE.2013.051651

Purwanti, I. (2021). Konsep Implementasi Ekonomi Sirkular dalam Program Bank Sampah (studi kasus: keberlanjutan bank sampah Tanjung). *AmaNu: Jurnal Manajemen Dan Ekonomi*, *4*(1), 89–98. https://jurnal.unugha.ac.id/index.php/amn/article/view/40/55

Puspitasari, R., Budimansyah, D., Sapriya, S., & Rahmat, R. (2023). Internalizing the Character Value of Caring for the Environment Through the Project to Strengthen the Profile of Pancasila Students in Elementary Schools. *IJORER : International Journal of Recent Educational Research*, *4*(6), 837–846. https://doi.org/10.46245/ijorer.v4i6.390

Ramli, S., Novanda, R., & Sobri, M. (2022). Concept Understanding, Environmental Care Character, and Student Responses in Elementary School Thematic Subjects. *Jurnal Ilmiah Sekolah Dasar*, *6*(2), 253–262. https://doi.org/10.23887/jisd.v6i2.44848

Rosniwaty, Hendratno, & Istiq'faroh, N. (2024). International Journal of Multicultural and Multireligious Understanding Environmental Care Character Profile of Elementary School Students in the Era of Independent Curriculum. *International Journal of Multicultural and Multireligious Understanding*, *11*(12), 133–139. https://doi.org/10.18415/ijmmu.v11i12.6304

Satria, R., Adiprima, P., Wulan, K. S., & Harjatanaya, T. Y. (2022a). Panduan Pengembangan Projek Penguatan Profil Pelajar Pancasila. In *Badan Standar, Kurikulum, Dan Asesmen Pendidikan* (pp. 1–137).

Satria, R., Adiprima, P., Wulan, K. S., & Harjatanaya, T. Y. (2022b). Projek Penguatan Profil Pelajar Pancasila. In *Projek Penguatan Profil Pelajar Pancasila*. Badan Standar, Kurikulum, dan Asesmen Pendidikan Kementerian Pendidikan, Kebudayaan, dan Teknologi Republik Indonesia.

Seandrio, A. R. (2019). *Menjaga Kebersihan Lingkungan*. Fakultas Kedokteran Universitas Riau.

Singarimbun, Masri, & Effendi, S. (2006). *Metode penelitian Survai*. Lembaga Penelitian dan Penerangan Ekonomi dan Sosial Indonesia.

Situmorang, R. O. P., Liang, T. C., & Chang, S. C. (2020). The difference of knowledge and behavior of college students on plastic waste problems. *Sustainability (Switzerland)*, *12*(19). https://doi.org/10.3390/SU12197851

Soemadijo, P., Anindita, F., Trisyanti, D., Akib, R., Abdulkadir, M., Nizardo, N. M., & Rachmawati, R. L. (2022). A Study of Technology Availability for Recycling Low. *Journal of Environmental Science and Sustainable Development*, *5*(2), 436–457. https://doi.org/10.7454/jessd.v5i2.1128

Solekah, N. A., Handriana, T., & Usman, I. (2022). Millennials' Deals with Plastic: The Effect of Natural Environmental Orientation, Environmental Knowledge, and Environmental Concern on Willingness to Reduce Plastic Waste. *Journal of Consumer Sciences*, *7*(2), 115–133. https://doi.org/10.29244/jcs.7.2.115-133

Sumiati, Agustin, R., Maulana, I., Rozikin, M. K., & Hikamah, S. R. (2024). Reduce ,

Reuse , dan Recycle (3R) sebagai Solusi terhadap Bahaya Banjir di Sekitas TPSS Kaliwates. *Al-Khidmah*, *4*(1), 13–26. https://doi.org/10.56013/jak.v4i1.2672

Syaharuddin, S., Hidayanti, H., & Mutiani, M. (2020). The Role of Waste Banks to Improve Community Environment Awareness. *The Innovation of Social Studies Journal*, *1*(2), 129. https://doi.org/10.20527/iis.v1i2.2026

Syahri, M., Widodo, M., & Sofwani, A. (2020). Environmental awareness of character building for students through the. *Journal of Southwest Jiaotong University*, *56*(6), 1–95. https://doi.org/10.35741/issn.0258-2724.56.6.55

Tarigan, M. I. (2021). Measuring Indonesia's Commitment to Reducing Plastic Waste in the Sea Through A Legal Approach. *Lambung Mangkurat Law Journal*, *6*(1), 103–118. https://doi.org/10.32801/lamlaj.v6i1.242

Trisyanti, D., Ranggi, K., Wengi, L., Rachmawati, R. L., & Akib, R. (2022). Advancing the Potential of Pet and Pp-Based Beverage Packaging To Support Circular Economy. *Journal of Environmental Science and Sustainable Development*, *5*(2), 378–403. https://doi.org/10.7454/jessd.v5i2.1154

Turyati, T., Hartati, S., & Nugraheni, N. (2020). Effectiveness of Project Based Learning (PjBL) to Improve Natural Science Learning Outcomes Of Grade IV Students. *Elementary School Teacher*, *3*(1), 34–39. https://doi.org/10.15294/est.v3i1.27921

Valentine, T. (2019). Peran bank sampah dalam pengelolaan sampah sebagai upaya pencegahan pencemaran lingkungan di kota Yogyakarta. *Αγαη*, *8*(5), 1–13.

Wibowo, N. A., Sarwono, & Yusup, Y. (2021). Environmental Care Attitude of the Students. *Jurnal GeoEco*, *7*(2), 165–177.

Zubaidah, S. (2020). Keterampilan Abad Ke-21: Keterampilan yang Diajarkan Melalui Pembelajaran. *Conference: Seminar Nasional Pendidikan Dengan Tema "Isu-Isu Strategis Pembelajaran MIPA Abad 21At: Program Studi Pendidikan Biologi STKIP Persada Khatulistiwa Sintang – Kalimantan Barat*, 1–17. https://www.researchgate.net/publication/318013627_Keterampilan_Abad_Ke-21_Keterampilan_yang_Diajarkan_Melalui_Pembelajaran

Online ISSN 2655-2450 | Print ISSN 2655-2388