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Greening Program as a Green Campus Strategy to Support SDG 12 (Responsible, Consumption, and Production) and Foster Environmental Care Attitudes Among Undergraduate Biology Students

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Abstract

This study evaluates the effectiveness of a participatory greening program in implementing a Green Campus and achieving SDG 12 among Biology students. A quantitative pre-experimental, one-group pre-test post-test design was employed with 36 undergraduate student selected by purposive sampling. Instruments included expert-validated knowledge tests, environmental questionnaires, and observation checklist (content validity index of 1.00). The four-week program involved activities such as planting, watering, weeding, fertilizing, and monitoring, specially designed to promote sustainable consumption and production practice-including organic fertilization efficient water usage, composting, and responsible resources management. Student participation averaged 78.6%. Statistical analysis using the Wilcoxon signed-rank test indicated a significant increase in environmental knowledge ($Z = -5.12$, $p < 0.001$) with a moderate-to-high N-gain score of 0.66. Additionally, students' environmental care attitude improved significantly, with the mean score rising from 72.4 to 88.7 ($\Delta = 16.3$), categorized as "very positive". These findings demonstrate that the greening program is empirically effective in improving ecological literacy and foresting pro-environmental attitude while reinforcing sustainable production principles. Therefore, this program can be adopted as a scalable and sustainable model for Green Campus initiative in higher education.

Keywords: Biology Students, Environmental Attitudes, Green Campus, Greening Program, SDGs 12, Sustainable Consumption and Production,

INTRODUCTION

The State University of Surabaya (UNESA), as one of Indonesia's public universities, plays a strategic role in supporting the achievement of the Sustainable Development Goals (SDGs). Higher education institutions are not only centers for education and scientific development but also agents of change in fostering sustainability awareness and environmentally responsible behavior among the academic community (Leal Filho et al., 2019).

In this context, universities are expected to integrate sustainability principles into campus policies, learning processes, and environmental management practices as part of their contribution to global sustainable development (UNESCO, 2020). One of the concrete efforts to realize this commitment is through the implementation of Green Campus programs, which emphasize environmentally friendly campus management, including greening, waste management, and resource efficiency

(Nugroho et al., 2022). Therefore, it is important to implement campus-based sustainability programs that not only improve environmental quality but also enhance students' knowledge and attitudes toward environmental responsibility. This study aims to evaluate the implementation of a participatory-based greening program in supporting Green Campus initiatives and improving students' ecological knowledge and environmental care attitudes.

At the national level, spatial planning policies emphasize the ecological importance of maintaining adequate Green Open Space (GOS) to support environmental balance, improve microclimate conditions, and enhance urban air quality (Gandasari et al., 2021). These principles align with broader environmental management frameworks that highlight the responsibility of all sectors, including higher education institutions, in promoting sustainable environmental practices. In this context, campus greening programs can be seen as part of a wider sustainability effort that integrates vegetation management, land rehabilitation, and resource efficiency to support environmental quality improvement (Astuti & Fadilah, 2021). Furthermore, sustainable waste management practices are increasingly recognized as a key component of institutional responsibility in reducing environmental impact and promoting circular resource use within campus environments.

The role of the community in environmental management is realized through public participation, which includes involvement in the process of planning, utilization, control, maintenance, and environmental supervision. This law also regulates the right of the public to obtain access to environmental information, participate in decision-making, and file objections or lawsuits for actions that damage the environment. Thus, the community is not only a beneficiary of the environment, but also a main driver in realizing sustainable development. Active community involvement is a determining factor for the success of various environmental programs, ranging from waste management, biodiversity conservation, greening, to climate change mitigation. Without the support of community participation, environmental management policies are often not effective (Lukito & Boediningsih, 2022).

The Faculty of Mathematics and Natural Sciences (FMIPA), especially the UNESA Biology Study Program, has strong ecological potential to implement the greening-based Green Campus concept. The existence of greenhouses, biological gardens, and open areas around Buildings C10 and C14 provide opportunities to be developed as functional green spaces that

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are not only aesthetic, but also educational. However, preliminary observation results show that some areas around the Biology Building are still not optimally arranged, with relatively arid soil conditions, limited vegetation, and lack of sustainable plant care. This condition shows the need for intervention in the form of a planned, participatory, and sustainable reforestation program to improve the quality of the campus environment while supporting the implementation of Green Campus.

Various studies have demonstrated that Green Campus initiatives and campus greening programs positively influence the development of students' environmental care attitudes. Active student involvement in activities such as tree planting and vegetation maintenance has been shown to enhance ecological awareness, foster a sense of environmental responsibility, and encourage pro-environmental behavior in daily life (Wulandari & Ardiansyah, 2020; Leal Filho et al., 2019; Ardoin et al., 2020; Disterheft et al., 2015; Findler et al., 2019). However, most previous studies have primarily focused on policy frameworks, institutional commitments, or students' perceptions of sustainability initiatives, while empirical research examining participatory-based reforestation programs that actively engage students as implementers and managers remains relatively limited, particularly in university contexts.

Based on these conditions, the greening program was initiated as a form of campus greening implementation involving UNESA Biology students directly in vegetation planting and maintenance activities. This program is designed not only as an effort to improve the quality of the physical environment of the campus, but also as a medium. Thus, this research aims to examine the implementation of the greening program as a Green Campus strategy, as well as analyze its influence on the attitude of environmental care of UNESA Biology students.

METHOD

This study employed a pre-experimental quantitative approach using a one-group pre-test–post-test design (Creswell, 2014) to examine the implementation of the greening program as a Green Campus strategy and its influence on the environmental care attitudes of Biology students at the State University of Surabaya (Maulinda et al., 2025). In this study, the SDG 12 variable is operationalized through indicators of environmental care attitudes, including responsible behavior in resource use, waste management awareness, and sustainable environmental practices (UN, 2015). The research was conducted over approximately four months, covering the stages of program preparation, socialization, implementation of

reforestation activities, and data evaluation and analysis. The reforestation program took place in the area surrounding Buildings C10 and C14 of the Biology Department, FMIPA, State University of Surabaya, while data processing and final report preparation were conducted at the Ecology Laboratory, Biology Department, FMIPA, State University of Surabaya.

The subjects of the study are UNESA Biology students of the 2024 and 2025 batches who are directly involved in the reforestation program with a total of 80 respondents from various generations and classes. Reforestation activities are carried out through several stages, including program socialization, land preparation and planting media, planting plants, and regular plant care. The types of plants used in this program consist of ornamental plants, family medicinal plants (TOGA), productive plants, and pollutant-absorbing plants that are adjusted to the conditions of the campus environment.

Data collection is carried out through several techniques, namely filling out student response questionnaires after the implementation of the program, providing pre-tests and post-tests before and after reforestation activities, as well as documentation of activities and the presence of students in plant care. The implementation of the program is assessed based on the level of student participation in plant planting and watering activities carried out on a scheduled basis.

The research instruments include response questionnaires, pre-tests and post-tests, as well as booklets on greening guidelines. The instrument was validated by material experts from the Department of Biology UNESA. The analysis of validation results was carried out using the following percentage formula:

$$Percentage = \frac{TotalScore}{TotalScoreMax} x100\% \quad ..(1)$$

(Source: Arkadiantika et al., 2020)

After the results are known, then describe the category of results to find out the extent of the validity of the research instrument. The description of the results is shown in Table 1.

Table 1. Rating Result Category

Category	Score
Highly Valid	82% - 100%
Valid	63% - 81%
Invalid	44% - 62%
Highly Invalid	25% - 43%

(Source: Subhaktiyasa, 2024)

This study uses pre-test and post-test scores to determine the increase in students' knowledge and environmental care attitudes. Environmental care attitudes were measured using a structured questionnaire based on a Likert scale (1–5), assessing indicators such as responsible behavior in resource use, waste management awareness, and participation in environmental conservation activities. The assessment criteria for the knowledge

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domain are presented in Table 2.

Table 2. Knowledge Aspect Criteria

Criteria	Score Difference
Excellent	75 - 100
Good	50 - 75
Enough	25 – 50
Less	0 - 25

(Source: Purwati & Mundilarto, 2021)

Table 2 shows the criteria for knowledge aspects to determine the extent of the results of understanding and improving students' environmental care attitudes.

N-Gain analysis was applied to evaluate the increase in the results of the study and the increase in students' environmental care attitudes. This analysis is determined through a formula that compares the difference in pre-test and post-test scores. The following formula and table of N-Gain value categories are shown in Table 3.

$$Gain = \frac{posttestscore - pretestscore}{maxscore - pretestscore} x100\% \quad ...(2)$$

Table 3. N-Gain Value Criteria

Gain Value	Criteria
n < 0.3	Low
0.3 ≤ n < 0.7	Medium
n ≥ 0.7	Height

(Source: Aprillia et al., 2022)

This study uses IBM SPSS Statistics 23 to analyze the data, ensuring accurate and reliable statistical calculations. To measure the increase in students' environmental care attitudes, the Wilcoxon signed-rank test was applied. This non-parametric test was chosen because the data were not assumed to be normally distributed and were measured using an ordinal Likert scale. Therefore, the Wilcoxon test is appropriate for analyzing differences between pre-test and post-test scores.

RESULT AND DISCUSSION

This research produced a product in the form of a Greening Booklet as a Green Campus Strategy to Support SDGs 12 and Train Environmental Care Attitudes of UNESA Biology Students. This booklet is a teaching material and practical guide specifically designed to assist in the implementation of reforestation programs in the campus environment of the State University of Surabaya, especially at the Faculty of Mathematics and Natural Sciences (FMIPA). The cover of the booklet shown in figure 1.



Figure 1. Booklet Cover

After the educational booklet is created, the next stage is the validation of the instrument by experts. This validation

involves two validators. Each validator is given a validation instrument sheet to provide an assessment of the research results. The following diagram of the booklet validation by the subject matter expert is presented in Figure 2.

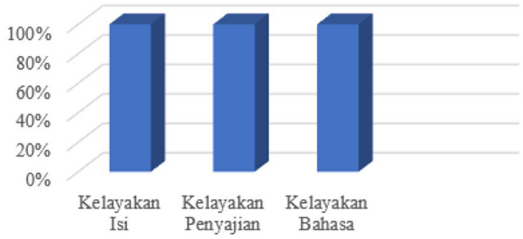

Figure 2. Booklet Validation Bar Diagram

Based on the recapitulation of the validation results above, a score of 100% was obtained, which means that the booklet is very valid to be used as ateaching tool and practical guide (Subhaktiyasa, 2024). The following is a bar diagram of the validation of the response questionnaire shown in Figure 3.

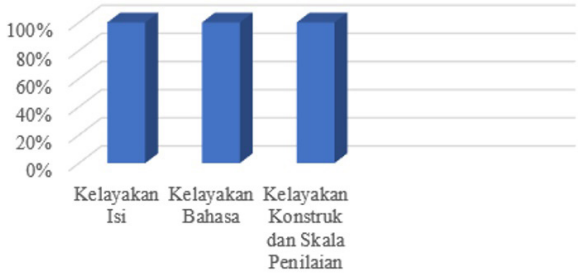

Figure 3. Response Questionnaire Validation Bar Diagram

Based on the recapitulation of the validation results above, it received a score of 100%, which means that the response questionnaire is very valid to be used as a teachingand learning tool (Subhaktiyasa, 2024). The following is a bar diagram of the validation of pre-test and post-test questions shown in Figure 4.

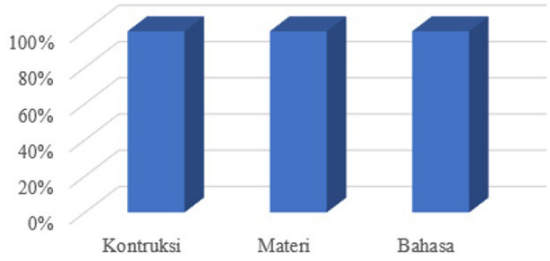

Figure 4. Daigram Rod Validation for Pre-test and Post-test

Based on the recapitulation of the validation results above, it gets a score of 100%, which means that the pre-test and post-test questions are very valid to be used as teachingand learning (Subhaktiyasa, 2024).

The implementation of the reforestation program is assessed based on the level of student participation in socialization, planting, watering, weeding, fertilizing, and monitoring plant activities. The results of observations show that more than 70% of students are actively involved in every stage of the activity. The following documentation of the activities is shown in Figure 5.a, 5.b, and 5.c.

The evaluation of the results of understanding and improving students' environmental care attitudes came from pre-test and post-test scores. The sample used is students of the 2024 and 2025 batches, with the number of students participating in filling out the pre-test and post-test as many as 80 students. Table 4 below shows the results of the recapitulation of the results of understanding and improving

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Figure 5.a. Program Sosialization



Figure 5.b. Implementation of Greening



Figure 5.c. Watering Implementation

students' environmental care attitudes.

Table 4. Value Recapitulation

Average Student Score	
Pre-test	51,37
Post-test	91,81

Based on the reactivity, it is known that the initial value is 51.37 and the final value is 91.81. Then a normality test was carried out to find out whether the data was normal or not. The test data can be seen in Table 5.

Table 5. Normality Test

Value	Statistic	Df	Sig.
Pre-test scores	0.941	80	0.001
Post-test scores	0.867	80	0.000

Table 5 shows the normality test value which shows a value of 0,001 at the pre-test value and 0,000 at the post-test value. From this result, it indicates that the results of the normality test show that the value is less than 0,05, which indicates that the data is not normal. After that, the analysis of student knowledge improvement was continued with the Wilcoxon Signed-Rank Test non-parametric test. The following results of the Wilcoxon Signed-Rank Test are shown in Table 6.

Table 6. Wilcoxon Signed-Rank Test

	Z	Asymp. Sig. (2-tailed)
Post-test – Pre-test	-7.786b	.000

The Wilcoxon Signed-Rank Test yields a value of 0.000 indicating a value smaller than 0.05. These results show that there is a significant increase in increasing students' knowledge and concern for greening in the campus environment. The results of the N-Gain test were obtained from 80 samples consisting of pre-test and post-test scores shown in the formula below.

$$Gain = \frac{91.81 - 51.37}{100 - 51.37} = 0.83$$

The results of the N-Gain test from 80 samples got an average score of 0,83, this value is at n ≥ 0.7, this fact proves that the average score is classified as high.

The results of the response questionnaire showed that students' attitude of caring for the environment was in the very positive category after

participating in the reforestation program, shown in Figure 6.

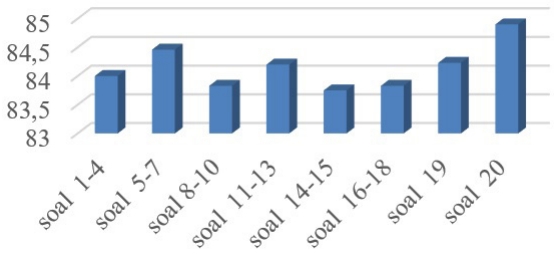

Figure 6. Response Questionnaire Bar Diagram

Based on the recapitulation, the results obtained a score of 84.15%, which means that the response questionnaire is very valid to be used and well received by students and is able to describe their responses positively and evenly to the content of the instrument (Subhaktiyasa, 2024).

The significant increase in students' environmental knowledge and caring attitudes after participating in the greening program indicates that experiential and participatory learning approaches play a crucial role in environmental education. This finding aligns with the constructivist learning theory, which emphasizes that knowledge is more effectively internalized when students are directly involved in real-world activities (, 2015).

The high N-Gain score (0.83) suggests that the intervention was highly effective. This result is consistent with recent studies showing that project-based environmental programs significantly enhance students' ecological literacy and pro-environmental behavior. For instance, research by Ardoin et al. (2020) found that hands-on environmental education programs can lead to long-term behavioral change and increased environmental awareness among students.

Furthermore, the positive student responses (84.15%) reflect not only cognitive improvement but also affective engagement. According to the theory of planned behavior (Ajzen, 2020), attitudes toward environmental actions strongly influence individuals' intentions and actual behaviors. Thus, the high level of student acceptance indicates that the greening program successfully fostered positive environmental attitudes that may translate into sustainable behavior. Compared to international studies, the findings of this research are in line with Leal Filho et al. (2018), who emphasized that Green Campus initiatives are effective in integrating sustainability into higher education through student engagement and campus-based activities. Similarly, research by Lozano et al. (2019) highlights that sustainability programs in universities significantly contribute to shaping environmentally responsible graduates.

In addition, the success of student participation (70%) supports the notion that active involvement is a key factor in environmental program effectiveness. Recent studies (Disterheft et al., 2016; Aleixo et al., 2021) indicate that student

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engagement in sustainability initiatives enhances not only knowledge but also responsibility and environmental stewardship.

However, while the results are promising, the short duration of the program limits the ability to assess long-term behavioral changes. Previous research suggests that sustained interventions are necessary to ensure that pro-environmental attitudes develop into consistent habits (Otto & Pensini, 2017). Therefore, future studies should incorporate longitudinal designs to evaluate long-term impacts.

Overall, this study contributes to the growing body of evidence that campus-based environmental programs are effective tools for promoting sustainability education, particularly when they integrate experiential learning, student participation, and real-world environmental action.

Although the program is running well, there are some limitations. The relatively short duration of implementation does not allow long-term observation of plant sustainability or sustainable changes in student behavior. A number of educational studies in Indonesia show that short duration of observation and small sample sizes limit the ability to evaluate the long-term effects of an intervention (Educendikia: Scientific Journal of Education, 2025). The number of respondents who participated in filling out questionnaires, pre-tests and post-tests was 80 students, although the initial target of the research included two batches, namely 2024 and 2025. In many educational studies in Indonesia, limited sample sizes and narrow scopes are limitations that researchers have limited to make it difficult to generalize the results to a wider population (Lubis et al., 2024). In addition, the limited sample size and research focus on only one study unit limits the ability to generalize research findings.

This condition can be explained by several factors. First, even though the questionnaire is filled out online through Google Form to make it more accessible to all students, there are still differences in the lecture schedule between classes and between batches which cause not all students to fill out the questionnaire at the specified time. Second, some students are also unable to access or fill out Google Forms because they are participating in mandatory academic agendas such as practicums or other off-campus activities, so they cannot respond during the data collection period. Third, the limitation of research time makes researchers have to set a deadline for filling out Google Forms so that only students whose schedules are aligned with the research agenda and can access the form on time are then recorded as respondents. In addition, the location of reforestation that is limited to one campus area limits the generalization of ecological

impacts. These limitations actually open up opportunities for further research, such as long-term plant growth monitoring, comprehensive evaluation of campus ecological impacts, and replication of program models in other faculties.

CONCLUSION

The implementation of the greening program as part of a Green Campus strategy has proven to be effective in supporting environmental education and positively contributes to localized SDG 12 targets. The greening booklet and research instruments demonstrated a very high level of validity (100%), indicating their suitability as instructional media and practical guidelines. The program was implemented effectively, with consistently high student participation in all stages of activities. The results showed a statistically significant improvement in students' environmental knowledge ($p < 0.05$), with an N-Gain score in the moderate category, along with very positive responses toward environmental care.

Importantly, the increase in knowledge has been internalized into the affective domain, reflected in the development of more positive attitudes and stronger environmental responsibility among students. Overall, the greening program not only improves the physical quality of the campus environment but also enhances ecological literacy and fosters pro-environmental behavior. Therefore, this program has strong potential to be developed and replicated as a sustainable Green Campus model in higher education.

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