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Effectiveness of the Plastic-Free Campus Movement in Promoting Sustainable Lifestyles and Supporting SDG 12.5 among Biology Students

Nikita Ar Rani[1*], Herlina Fitrihidajati[1], Adi Candra[2], Nurcholis[2]
[1] Biology Education, State University of Surabaya, Surabaya, Indonesia
[2] Lestari Bumi Abadi Foundation, Gresik, Indonesia
[*]E-mail: nikita.23115@mhs.unesa.ac.id

Abstract

Single-use plastic waste remains a major environmental challenge on university campuses due to its intensive use and low degradability, increasing waste management burdens and pollution risks. This study evaluated the effectiveness of the Plastic-Free Campus Movement in promoting sustainable lifestyles among Biology students and reducing single-use plastic waste on campus. A one-group pre-test–post-test pre-experimental design with quantitative descriptive and observational approaches was employed involving 80 Biology and Biology Education students at the Faculty of Mathematics and Natural Sciences, State University of Surabaya. Data were collected through pre-tests, post-tests, attitude and response questionnaires, and waste-volume observation sheets, and analysed using descriptive statistics, the Shapiro–Wilk normality test, the Wilcoxon signed-rank test, and N-gain analysis. The educational media and research instruments were highly valid with a feasibility score of 100%. Students' knowledge increased significantly from 54.55 to 92.76 ($p < 0.05$) with a high N-gain score (0.84). Student attitudes (84.55%) and programme responses (82.47%) were categorised as very good. In addition, the average plastic waste-bin occupancy decreased from an overflow condition equivalent to 104% of bin capacity in the first week to 24% of bin capacity by the fourth week. These findings demonstrate that the Plastic-Free Campus Movement effectively improved students' environmental awareness and sustainable behaviour while contributing to measurable reductions in campus plastic waste, providing a practical educational strategy to strengthen Green Campus initiatives and support SDG 12.5.

Keywords: Environmental Education, Green Campus, Plastic Waste, SDGs 12.5, Sustainable Lifestyle.

INTRODUCTION

Single-use plastic waste remains one of the most persistent environmental challenges because of its extensive use and low degradability. Inadequate plastic waste management contributes to environmental pollution and prolongs the persistence of waste residues in terrestrial and aquatic ecosystems (Diartika & Sueb, 2021). Furthermore, the presence of microplastics in aquatic environments demonstrates that plastic waste can fragment into smaller particles and interact with suspended solids, posing potential risks to ecosystem health (Wulandari et al., 2022). Universities are among the institutions that contribute to plastic waste generation through academic and non-academic activities, including lectures, laboratory sessions, student organization activities, and campus mobility, all of which encourage the frequent use of

single-use food and beverage packaging. Consequently, reducing plastic waste on university campuses has become an important component of sustainable consumption and production

Indonesia has established a comprehensive regulatory framework to support sustainable waste management. Law No. 18 of 2008 on Waste Management, Law No. 32 of 2009 on Environmental Protection and Management, and Government Regulation No. 22 of 2021 provide the legal foundation for systematic waste reduction, environmental protection, and sustainable waste management. In addition, national policy targets aim to achieve a 30% reduction in waste generation and 70% waste management by 2025. Achieving these targets requires not only improvements in waste management systems but also behavioural changes among individuals and communities to encourage waste prevention, reduction, recycling, and reuse.

Higher education institutions play a strategic role in promoting environmental literacy and fostering sustainable lifestyles among students. Previous studies have shown that successful Green Campus implementation requires institutional commitment, adequate facilities, effective waste management systems, and active participation from the academic community (Pascawati et al., 2023; Syaputri et al., 2023). Waste management is also recognised as one of the principal indicators of Green Campus performance because it reflects institutional efforts in waste reduction, segregation, and sustainable resource management (Nurbaiti, 2024). These efforts directly support Sustainable Development Goal (SDG) 12.5, which emphasizes reducing waste generation through prevention, reduction, recycling, and reuse (United Nations Statistics Division, 2024). Accordingly, universities are expected not only to provide environmentally supportive infrastructure but also to cultivate sustainable behaviours through education and campus policies (Rachmadian et al., 2025).

Environmental education has been widely recognised as an effective approach for promoting pro-environmental behaviour. Previous studies have reported that students' environmental knowledge and attitudes are positively associated with environmentally responsible behaviour (Gabriella & Sugiarto, 2020). According to the Theory of Planned Behavior, behavioural intention and perceived behavioural control are important determinants of individuals' decisions to reduce single-use plastic consumption (Nu'man & Noviati, 2021). Educational media, such as booklets and posters, can reinforce environmental messages by providing structured information and continuous visual reminders, while social campaigns help strengthen awareness and

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encourage behavioural change (Anggraini & Aryanto, 2020; Reskiaddin et al., 2024).

Despite these findings, previous studies have primarily focused on improving environmental awareness, knowledge, or behavioural intentions, whereas evidence demonstrating whether educational interventions can simultaneously produce measurable educational outcomes and tangible environmental impacts remains limited. In particular, few studies have evaluated the effectiveness of integrated educational media using both behavioural indicators and objective measures such as changes in plastic waste volume within university environments. This gap highlights the need for more comprehensive evaluations of campus-based environmental education programmes.

This study offers a novel contribution by integrating educational socialization, booklets, and strategically placed posters into a single Plastic-Free Campus Movement programme and evaluating its effectiveness using multiple outcome indicators, including students' knowledge, attitudes, programme responses, and observed plastic waste volume. By combining educational and environmental indicators, this study provides empirical evidence of how environmental education can contribute to Green Campus implementation while supporting SDG 12.5 through measurable behavioural and environmental improvements.

Initial observations were conducted in the Biology Department buildings (C10 and C14), which serve as the primary locations for lectures, laboratory activities, and student discussions. These high-traffic areas consistently generate considerable amounts of single-use plastic waste, making them appropriate sites for evaluating campus-based environmental interventions. This condition indicates the need for interventions that not only provide environmental information but also promote habit formation and reinforce pro-environmental behavioural norms. Therefore, this study aimed to evaluate the effectiveness of the Plastic-Free Campus Movement by assessing the validity of the educational media and research instruments, examining improvements in students' knowledge, attitudes, and programme responses, and identifying changes in plastic waste volume as an indicator of Green Campus implementation in support of SDG 12.5.

METHOD

TThis study employed a pre-experimental one-group pre-test-post-test design using quantitative descriptive and observational approaches. The design was selected to evaluate changes in students' knowledge before and after the implementation of the Plastic-Free Campus Movement programme. The

intervention was conducted in the Biology Department buildings (C10 and C14), Faculty of Mathematics and Natural Sciences, State University of Surabaya. These buildings serve as the primary locations for lectures, laboratory activities, and student discussions, making them high-traffic areas where single-use plastic waste is frequently generated. The intervention consisted of educational socialization sessions and booklet distribution on September 22, 2025, followed by the installation of educational posters on October 1, 2025, at strategic locations, including the C14 lobby and discussion areas.

The participants consisted of 80 undergraduate students enrolled in the Biology and Biology Education programmes from the 2024 and 2025 cohorts. Participants were selected purposively because they regularly attended academic activities within the intervention area and represented the primary target group of the Plastic-Free Campus Movement programme. Although the educational intervention was delivered exclusively to these participants, observations of plastic waste were conducted in the shared public areas of the intervention site to evaluate environmental conditions associated with programme implementation rather than waste generated solely by the participants.

The study measured four variables: students' knowledge of plastic waste and sustainable lifestyles, students' attitudes toward sustainable lifestyles, students' responses to the programme, and environmental indicators represented by single-use plastic waste observed at the intervention site.

The research instruments consisted of (1) a 17-item pre-test and post-test to measure students' knowledge, (2) a 20-item attitude questionnaire covering cognitive (Items 1–4), affective (Items 5–8), conative (Items 9–12), and active behavioural aspects (Items 13–20), (3) an 18-item programme response questionnaire covering presentation (Items 1–6), language (Items 7–9), and content (Items 10–18), and (4) an observation sheet used to record the amount of single-use plastic waste at the observation sites.

Knowledge scores were calculated from the proportion of correct answers and converted to a 0–100 scale. The attitude and response questionnaires employed a four-point Likert scale ranging from 1 (strongly disagree) to 4 (strongly agree). Scores for each aspect were summed and converted into percentages of the maximum possible score to facilitate interpretation.

Plastic waste observations were conducted using visual estimation of rubbish-bin occupancy. The proportion of single-use plastic waste occupying the waste bin was recorded as a percentage of the total capacity of a 100-L waste bin. Values exceeding 100% indicated that the

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waste exceeded the bin capacity (overflow condition). Weekly observations were carried out throughout the intervention period to monitor changes in plastic waste accumulation within the intervention area.

Prior to data collection, the educational media and research instruments were evaluated through expert judgement by two experts to assess content suitability, language clarity, construct appropriateness, and presentation quality. The validation results confirmed that all media and instruments were suitable for implementation.

Data collection was carried out in three stages. First, participants completed the pre-test before receiving the intervention. Second, the Plastic-Free Campus Movement programme was implemented through educational socialization, booklet distribution, and poster installation. Finally, participants completed the post-test, attitude questionnaire, and programme response questionnaire after the intervention, while plastic waste observations were conducted weekly throughout the observation period.

Data were analysed using descriptive and inferential statistics. Descriptive statistics, including means, standard deviations, and percentages, were used to summarise knowledge scores, attitude scores, response scores, and waste observation results. The Shapiro-Wilk test was performed to assess the normality of pre-test and post-test knowledge scores. Because the data were not normally distributed, differences between pre-test and post-test scores were analysed using the Wilcoxon Signed-Rank test. The effectiveness of the intervention was further evaluated using the normalized gain (N-gain), which was interpreted as low (<0.30), moderate (0.30–0.69), or high (≥0.70). Plastic waste observation data were analysed descriptively by comparing the weekly percentage of waste-bin occupancy to identify trends in plastic waste accumulation throughout the intervention period.

RESULT AND DISCUSSION

The Plastic-Free Campus Movement program was implemented through socialization, distribution of educational booklets, and installation of posters at student activity points. The booklet served as an information medium containing reasons and action steps, while the posters served as brief visual reminders that reinforced daily decisions. The media used in the program shows in Figure 1 and Figure 2. The documentation of the program implementation are shown in Figure 3 and Figure 2.

Media and instrument validation was conducted to ensure that the Plastic-Free Campus Movement program was supported by valid educational materials and reliable research instruments before



Figure 1. Cover of the educational booklet used as a comprehensive information media



Figure 2. Poster used as a visual reminder to reduce single-use plastics



Figure 3. Program socialization activities for students



Figure 4. Installation of posters at strategic points in the C14 lobby as visual reminders

implementation. The results of the validity assessment are presented in Table 1.

As presented in Table 1, all educational media and research instruments achieved validity scores within the acceptable category and were considered suitable for implementation without requiring revision. These findings indicate that the booklet, promotional poster, knowledge test, attitude questionnaire, response questionnaire, and observation sheet were appropriate for supporting the educational intervention and data collection. The high validity scores suggest that the educational materials effectively conveyed the intended messages, while the research instruments were capable of measuring students' knowledge, attitudes, responses, and environmental outcomes consistently. Therefore, the validated media and instruments provided a reliable foundation for evaluating the effectiveness of the Plastic-Free Campus Movement program.

After the educational media and research instruments were confirmed to be valid, the effectiveness of the Plastic-Free Campus Movement program was evaluated by comparing students' knowledge before and after the educational intervention. Knowledge was assessed using pre-test and post-test instruments covering plastic waste management, Green Campus principles, sustainable lifestyles, and SDG 12.5. The descriptive statistics of students' knowledge scores are presented in Table 2.

As shown in Table 2, the mean knowledge score increased from 54.55 in the pre-test to 92.76 in the post-test, indicating a substantial improvement following the educational intervention. The increase suggests that students gained a better understanding of plastic waste management, Green Campus concepts, sustainable lifestyles, and the role of SDG

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Table 1. Result of Media And Research Instrument Validity

Media/ Instruments	Aspect	Validator 1 (%)	Validator 2 (%)	Average score (%)	Description
Educational booklet	Content suitability	100	100	100	Suitable for use without revision
	Presentability	100	100	100	Suitable for use without revision
	Language suitability	100	100	100	Suitable for use without revision
Poster	Content suitability	100	100	100	Suitable for use without revision
	Design and presentation suitability	100	100	100	Suitable for use without revision
	Engagement and motivation for action	100	100	100	Suitable for use without revision
	Language suitability	100	100	100	Suitable for use without revision
Pre-test & Post-test	Construction aspects	100	100	100	Suitable for use without revision
	Material aspects	100	100	100	Suitable for use without revision
	Language aspects	100	100	100	Suitable for use without revision
Attitude survey	Content suitability	100	100	100	Suitable for use without revision
	Language suitability	100	100	100	Suitable for use without revision
	Construct validity and rating scales	100	100	100	Suitable for use without revision
Response survey	Content suitability	100	100	100	Suitable for use without revision
	Language suitability	100	100	100	Suitable for use without revision
	Construct validity and rating scales	100	100	100	Suitable for use without revision

12.5 in reducing waste generation. This finding indicates that the combination of socialization, booklet distribution, and poster installation effectively enhanced students' environmental knowledge (Ardoin et al., 2020; Suárez-Perales et al. (2021).

Before testing the difference between

Table 2. Descriptive Statistics of Knowledge Scores

Parameter	Pre-test	Post-test
N	80	80
Minimum score	36	80
Maximum score	78	100
Mean	54,55	92,76
Std. Deviation	8,34827	5,58761

the pre-test and post-test scores, the normality of the data was examined using the Shapiro–Wilk test. The results of the normality and difference tests are presented in Table 3 and Table 4, respectively.

Table 3. Shapiro-Wilk normality test results

	Statistic	N	Sign
Pretest	0.971	80	0.064
Postest	0.883	80	0.000

Table 4. Wilcoxon Signed-Rank Test Non-Parametric Test Results

	Z	Sig. (2-tailed)
Post-test – Pre-test	-7.775	0.000

The Shapiro–Wilk test indicated that the knowledge scores were not normally distributed; therefore, the Wilcoxon Signed-Rank test was applied. As presented in Table 4, the analysis revealed a statistically significant difference between the pre-test and post-test scores ($p < 0.05$), confirming that the educational intervention significantly improved students' knowledge. Improved knowledge is considered an essential prerequisite for behavior change because individuals are more likely to adopt environmentally responsible practices when they understand the environmental consequences of their actions and the available alternatives.

To further evaluate the effectiveness of the educational intervention, the normalized gain (N-Gain) was calculated. The N-Gain results and the distribution of participants across improvement categories are presented in Table 5 and Figure 5, respectively.

Table 5. N-Gain Test Result

Pre-test	Post-test	N-Gain Score	Crite-ria	N-Gain Score (%)	Crite-ria
54.55	92.76	0.84	High	83.72	Effec-tive

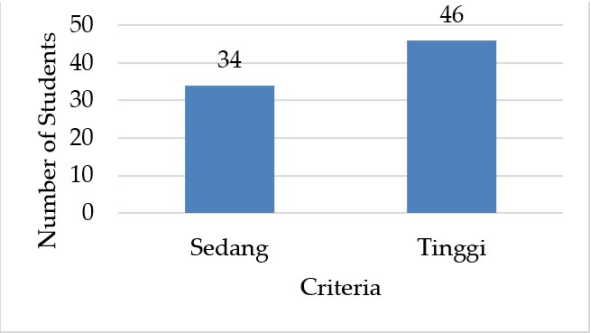


Figure 5. N-Gain Category Distribution Results

As shown in Table 5 and Figure 5, most participants achieved a high level of learning improvement, with an average N-Gain score of 0.84. These findings indicate that the combination of educational socialization, booklet distribution, and visual reinforcement through posters not only increased students' immediate test performance but

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Table 6. Student Attitude Survey Results

Aspect	Question item	Maximum score	Average score	Percentage (%)
Cognitive	Items 1-4	16	13.75	85.94
Affective	Items 5-8	16	13.36	83.52
Conative	Items 9-12	16	13.45	84.06
Active	Items 13-20	32	27.10	84.69
Average percentage (%)			84.55	

also produced substantial learning gains. The results demonstrate that integrating multiple educational media can effectively strengthen students' understanding of plastic waste reduction and encourage greater awareness of sustainable practices within the Green Campus initiative.

In addition to knowledge, the program assessed students' attitudes toward sustainable lifestyles on campus. The results of measuring students' attitudes toward sustainable lifestyles are presented in Table 6.

Attitudes were rated as excellent in all aspects. These results show that students not only understand the concept, but also accept values and behavioral tendencies that are in line with plastic reduction. A strong attitude is important because sustainable lifestyle changes require consistency in small daily decisions, such as carrying a water bottle, bringing a lunch box, using reusable containers/bags, and refusing plastic straws (Vicente-Molina et al., 2018). Within the SDGs framework, this attitude is social capital that supports target 12.5 through waste reduction at the source.

Student responses to the program describe acceptance, perceived benefits, and ease of implementation. A summary of student responses to the Plastic-Free Campus Movement Program is shown in Table 7.

Student responses were in the excellent category. The content aspect received the highest score, while the presentation aspect obtained a relatively lower score than the other aspects. These findings suggest that the educational materials were considered relevant, understandable, and useful by the participants, although improvements in visual design and presentation could further enhance user engagement. Positive

Table 7. Student Response Survey Results

Aspect	Question item	Maximum score	Average score	Percentage (%)
Presentation	Items 1-6	24	19.84	82.66
Language	Items 7-9	12	9.69	80.73
Content	Items 10-18	36	30.25	84.03
Average percentage (%)			82.47	

responses to educational media are important because participants are more likely to adopt and sustain recommended behaviors when the learning materials are perceived as attractive, accessible, and applicable to their daily activities (Mayer, 2021; Null et al., 2024). Therefore, these findings can be used as a basis for improving the appearance of the media, varying the design, or strengthening the distribution strategy so that the booklet is read more frequently and the posters attract greater attention. The positive response also indicates that the program has strong potential for long-term implementation, as participant acceptance is a key factor influencing the sustainability of campus-based environmental interventions (Ardoin et al., 2020).

The final evaluation focused on environmental output indicators reflected by changes in the volume of single-use plastic waste at the observation points. The progressive reduction in plastic waste accumulation over the observation period. During the first week, waste bins were observed to be highly filled, indicating intensive use of single-use plastics in students' daily activities. In the following weeks, the amount of visible plastic waste gradually decreased, suggesting an improvement in students' waste reduction behavior after the implementation of the educational intervention.

The average percentage of plastic waste volume consistently decreased from 104% in Week 1 to 82% in Week 2, 51% in Week 3, and 24% in Week 4 as shows in Figure 6. The first-week value exceeding 100% indicates that the waste bins surpassed their intended capacity, whereas the continuous decline observed in subsequent weeks suggests that the Plastic-Free Campus Movement program contributed to reducing the generation of single-use plastic waste in the Biology Buildings C10 and C14.

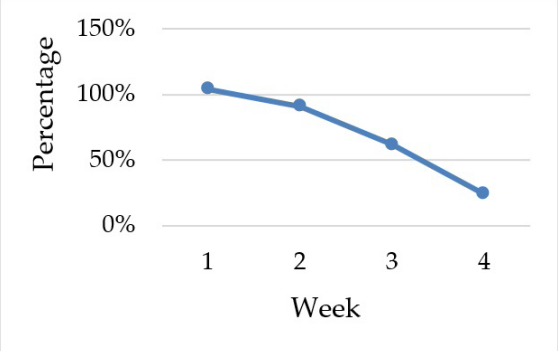


Figure 6. Trend in the percentage of plastic waste volume during the four-week observation period

The gradual reduction in plastic waste volume suggests that educational interventions combining socialization, booklet distribution, and poster installation were able to influence students' daily consumption behavior (Leal Filho et al., 2019). The socialization sessions provided students with fundamental knowledge regarding plastic waste management and sustainable lifestyles, while the booklet functioned as a comprehensive learning resource that could be reviewed independently. In addition, posters

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installed at strategic campus locations served as continuous visual reminders that reinforced environmentally responsible behavior during routine campus activities. Together, these educational components encouraged students to reduce their dependence on single-use plastics and adopt more sustainable consumption practices.

The observed reduction in plastic waste volume appears to be supported by the substantial improvement in students' environmental knowledge presented in the previous section. Better understanding of plastic waste management, Green Campus principles, sustainable lifestyles, and SDG 12.5 likely encouraged students to make more environmentally responsible decisions in their daily activities (Ardoin et al., 2020). This finding is consistent with the view that sustainability education becomes more effective when educational messages are directly connected to learners' everyday experiences, allowing knowledge to develop into environmentally responsible behavior (Lim et al., 2022).

The decrease in waste volume was also accompanied by positive student attitudes toward sustainable lifestyles and favorable responses to the educational media. These findings indicate that the intervention not only improved students' cognitive understanding but also strengthened their environmental awareness and acceptance of the educational materials. According to the Value-Belief-Norm Theory, pro-environmental behavior is influenced by individuals' environmental values, beliefs regarding environmental consequences, and personal norms that motivate responsible action (Stern, 2000). Similarly, studies based on the Theory of Planned Behavior suggest that clear educational messages, supportive social norms, and perceived behavioral control play important roles in encouraging plastic reduction behavior (Barnes Truelove et al., 2023; Vicente-Molina et al., 2018).

From a Green Campus perspective, the reduction in plastic waste volume demonstrates that the program contributed not only to improving students' environmental literacy but also to achieving measurable environmental outcomes (Findler et al., 2019). Rather than merely transferring waste to disposal facilities, the observed decline reflects waste prevention at its source through reduced consumption of single-use plastics. This outcome is directly aligned with SDG 12.5, which emphasizes substantially reducing waste generation through prevention, reduction, recycling, and reuse (United Nations Statistics Division, 2024). Similar findings have been reported in higher education institutions, where combining environmental education with institutional support has been shown to strengthen sustainable campus practices and reduce waste generation (Martínez-Acosta et al.,

2023; Rodríguez-Guerreiro et al., 2024).

Despite these positive outcomes, the waste volume observations still have several limitations. Waste generation may fluctuate according to students' daily activities, campus occupancy, and variations in packaging types. Furthermore, waste volume alone does not fully represent the quantity of plastic waste produced because different plastic materials occupy different volumes. Future programs should therefore complement volume observations with additional indicators, such as waste weight or the number of dominant plastic items, to improve measurement accuracy. Strengthening institutional support through adequate waste segregation facilities, refill water stations, and campus policies restricting single-use plastics would further enhance the long-term effectiveness of the Plastic-Free Campus Movement program (Vicente-Molina et al., 2018)

CONCLUSION

The Plastic-Free Campus Movement programme, implemented through educational socialization, booklets, and strategically placed posters, demonstrated that the developed educational media and research instruments were appropriate for implementation based on expert validation. The programme was effective in improving students' knowledge of plastic waste management and sustainable lifestyles, accompanied by highly positive attitudes and favourable responses toward the intervention. In addition, observations conducted throughout the programme indicated a substantial reduction in the occupancy level of waste bins by single-use plastic waste over the observation period, suggesting positive environmental changes within the intervention area. These findings indicate that integrating educational activities with continuous visual reminders can support behavioural change and contribute to Green Campus implementation while advancing SDG 12.5 through plastic waste reduction.

Based on these findings, universities are encouraged to integrate plastic reduction programmes into institutional sustainability policies, strengthen continuous environmental education, and establish routine waste monitoring systems to evaluate programme effectiveness. Future studies are recommended to employ stronger experimental designs, such as the inclusion of control groups or longitudinal observations, and to use more objective environmental indicators to better establish causal relationships between educational interventions and changes in environmental behaviour.

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