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Determining the Association between Environmental Education and Undergraduate Students' Awareness, Attitudes and Sustainable Practices

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Abstract

In Bangladesh, which has been extremely vulnerable to climate change and environmental degradation, EE is becoming more and more essential to the sustainable development. University students are important actors in building a sustainable society as they are about to become professionals, leaders, and decision-makers. Comparative analysis of environmental awareness, attitudes and sustainable behaviors of undergraduate students from universities in Bangladesh, between environment-related students (Target Cohort) and general academic students (General Cohort) was carried out in this study. The quantitative comparative design was used and data analyzed using independent-samples t-tests and Pearson's correlation analysis. The Target Cohort scored significantly higher than the General Cohort in environmental awareness, $t(185.7) = 15.55$, $p < .001$, Cohen's $d = 1.57$; environmental attitude, $t(129.8) = 5.59$, $p < .001$, Cohen's $d = 0.73$; and sustainable behaviour, $t(127.0) =$

3.63, $p < .001$, Cohen's $d = 0.48$. In the entire sample ($N = 196$), environmental awareness was significantly positively correlated with sustainable behaviour ($r(194) = .33$, $p < .001$) as well as with environmental attitude ($r(194) = .70$, $p < .001$). The results suggest that formal EE is linked to increased EE knowledge and EE related sustainable behaviors among undergraduate students. However, given the cross-sectional design and single-university setting, the findings should be interpreted as associative rather than causal. The study underscores the need to enhance EE and to make EE a cross-cutting theme in curricular subjects to help build environmentally aware attitudes and behaviours in the longer term.

Keywords: Awareness, Attitude, Environmental education, General cohort, Target cohort, Sustainable practice.

1. Introduction

Climate change and environmental degradation are one of the most critical problems in the 21st century that threaten environmental integrity, economic growth and welfare worldwide. With the increasing temperature, loss of biodiversity, pollution, and unsustainable use of natural resources, the concern for the long-term sustainability of natural and human systems is now more drilled into us. There are technological and policy solutions to these problems, but also solutions in the form of knowledge, attitudes and behaviors of people toward the environment. Therefore, EE has been given a greater focus as a strategic option for building the environmental literacy of citizens in the process of promoting sustainable lifestyles (Bayaer & Cui, 2023).

Environmental Education is a lifelong learning process, in which knowledge, skills, values and attitudes are acquired to comprehend environmental issues and participate in their solutions. It raises awareness on issues like climate change, pollution, biodiversity loss, resource depletion, etc., and develops practical skills in conservation, waste management, sustainable living, etc. (Fang et al., 2022). The potential importance of EE for international recognition is seen in the Sustainable Development Goals of the UN, among others Goal 4 (Quality Education) (United Nations, 2016) and Goal 13 (Climate Action) (United Nations, 2023).

It is generally accepted that one of the outcomes of EE is the development of environmental awareness, attitudes and sustainable practices. Awareness is the understanding and knowledge of environmental issues and their implications (Carrion-Bosquez et al., 2024); attitudes are feelings, perceptions, and intentions towards protecting and conserving the environment (DeVille et al., 2021); and sustainable practices are actions that help reduce the ecological impact, preserve biodiversity, and support sustainable use of resources (Ukpoju et al., 2024).

Environmental education programs and their target groups, particularly undergraduate students, are very important. The University level students hold immense potential to influence future environmental decision making and sustainable development activity in their future profession, in policy making, education and community leadership (Gupta et al., 2024; Saha et al., 2025). Higher education institutions are key actors in promoting sustainability by

incorporating sustainability concepts into the curricula, conducting research on sustainability issues, promoting innovation and influencing the sustainable behaviors of the students and adjacent communities (Marwala, 2025; Zaidan et al., 2023). It is therefore essential to have an understanding of the relevance of EE in the life of university students to be able to develop strategies for EE that can lead to sustainable change in society.

While there is generally agreement that EE is needed, there is less agreement on its effectiveness. The majority of studies have found positive correlations between EE and improvements in environmental knowledge, environmental awareness, and pro-environmental attitude, while other studies have indicated that an increase in environmental awareness and a positive attitude do not necessarily result in an environmentally responsible everyday behavior. A variety of factors have been suggested as influencing the likelihood that knowledge and attitudes will lead to behaviour change, including: experience; social norms; participation in the community; and continued educational messages. These inconsistencies indicate that there is a lack of research on the mechanisms under which EE has an impact on sustainable behavior, and on the contexts that determine these connections.

Bangladesh is a highly climate-vulnerable country as it is experiencing a rise in temperature, extreme weather events, flooding, cyclones and increasing coastal salinity intrusion (Germanwatch, 2021; IPCC, 2022; World Bank, 2021, 2024), along with high population density and its dependence on climate-sensitive sectors like agriculture. These pressures also impact biodiversity, livelihoods, food security and public health, and it is particularly important to focus on the environmental education of people of younger age group in order to encourage environmental responsibility and motivate them to take action to protect the environment, which is why this study has been limited to Bangladeshi undergraduates, specifically rather than a broader population.

Some studies have explored the link between EE and environmental behaviour in different contexts but few empirical studies have explored the relationships between EE, environmental awareness and environmental attitudes with sustainable practices among university students specifically in Bangladesh; and limited evidence examined the relationship of increased awareness with positive attitudes and sustainable practices among university students. It is important to address this gap, not only from a theoretical perspective that contributes to the existing body of literature on EE and behavior change, but also because it offers a standard to inform the development of EE curricula and sustainability programs for teachers, administrators and policymakers.

This study, therefore, examined the association between EE and undergraduate students' awareness, attitudes and sustainable practices, with a focus on measuring students' environmental awareness; examining students' attitudes towards environmental protection; assessing students' sustainable-practice behaviors; and investigating the students' relationships between the constructs. The study examines these dimensions with a Bangladesh context to provide empirical evidence to the extensive debate on EE and sustainability in climate-sensitive countries.

The hypotheses were developed based on the literature reviewed above; they are as follows:

H1: Environmental education is positively related to environmental awareness among undergraduate students.

H2: Environmental education is positively related to students' environmental attitudes toward environmental protection.

H3: Environmental education is positively related to sustainable practices among undergraduates.

H4: Environmental awareness is positively correlated with sustainable practices.

H5: Positive environmental attitudes are positively related to increased involvement in sustainable practices.

These hypotheses were tested via a quantitative research design that involved measuring EE exposure and the relationship between EE and environmental awareness, attitude and sustainable practices, respectively. Direct and indirect relationships between study variables can be explored and evidence can be provided of the association between EE and sustainability-related behaviors among undergraduate students with this design.

2. Method

2.1 Study Area and Population

The research was carried out at a university in the Chattogram district of Bangladesh. The sample comprised undergraduates from different departments and institutes across the university. The sample size was 196 students, representing 28 departments and institutes, sampled to capture a range of academic backgrounds. Students were categorized into two groups: the Target Cohort, comprising students from Forestry and Environmental Science and Geography and Environmental Studies, and the General Cohort, comprising students from non-environmental disciplines. This purposive sampling approach ensured that participants came from both environmentally oriented and general disciplines, enabling direct comparison in line with the study objectives. Table 1 presents the methodological matrix of the study, outlining its purposes, methodological approach and components.

2.1.1 Inclusion and Exclusion Criteria

Eligible participants were currently enrolled undergraduate students at the participating university, recruited either in person during class sessions or via the department-level Google Forms link circulated by class representatives. Participation was voluntary and based on informed consent; no age, gender, or year-of-study restrictions were applied beyond current undergraduate enrolment. Of 202 questionnaires received, 6 were excluded prior to analysis for incomplete responses, leaving 196 valid responses for analysis.

Table 1. Methodology matrix of the study

Research Component	Methodological Approach	Purpose
Research Design	Quantitative, comparative design	To measure and compare awareness, attitudes, and behaviors between environmentally and non-environmentally educated students.
Sampling Strategy	Purposive sampling	To ensure inclusion of both environmentally focused and general students for comparative analysis.
Data Collection	Structured, self-administered questionnaire with three sections	To gather standardized data on students' environmental knowledge, values, and practices.
Variables	Independent: Academic discipline (Target *vs.* General Cohort); Dependent: Awareness, Attitudes, and Sustainable Behaviors	To examine the relationship between environmental education exposure and the key outcome variables.
Data Analysis	Descriptive statistics, comparative mean analysis, bar chart visualizations, and correlation analysis	To identify differences between groups and explore patterns or associations among the variables.
Ethical Considerations	Anonymity and confidentiality ensured; informed consent obtained; voluntary participation; no personal identifiers collected	To protect participant rights and uphold ethical standards throughout the research process.

Note. Table adapted from the study's methodological framework.

2.2 Research Design

This research adopted a quantitative comparative research design. The primary aim of the study was to investigate the effects of environmental education on undergraduate students across two groups: an environmentally oriented group and a non-environmentally oriented group. This design offered objective measurement of three key variables (awareness, attitudes and behaviors) using structured survey tools, with comparative analyses applied to determine differences and correlations. This design was selected to ensure objectivity, replicability and generalizability across a large volume of data.

2.3 Data Collection Tools and Techniques

Data were collected using a questionnaire developed specifically for the study. The instrument comprised three major sections: (1) Environmental Awareness, (2) Environmental Attitudes, and (3) Sustainable Behavioral Practices. Awareness was measured using a three-point

familiarity scale applied to key environmental terms. The Attitudes and Sustainable Behavior sections shared a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree, measuring students' environmental concerns, values, and self-reported frequency of sustainability-related practices.

The questionnaire was reviewed for content validity by the corresponding author's academic supervisor, an Associate Professor at the Institute of Education and Research (IER), prior to piloting. A pilot test was then conducted with 12 students from the same university; these pilot responses were not included in the main analysis. Each of the three sections initially contained 15 items. Pilot participants reported that this length was burdensome to complete, and the item pool was subsequently reduced to 11 items (Environmental Awareness), 10 items (Environmental Attitudes), and 11 items (Sustainable Behavioral Practices) in the final instrument, retaining the items judged most central to each construct.

Internal consistency of the three scales was acceptable to excellent: Cronbach's alpha was 0.80 for the Environmental Awareness scale (11 items), 0.90 for the Environmental Attitudes scale (10 items), and 0.88 for the Sustainable Behavioral Practices scale (11 items).

2.4 Data Collection Period and Mode

Data were collected over approximately 12 weeks, from 7 March 2025 to 28 May 2025, using a mixed-mode procedure. Online responses were gathered via a Google Forms link distributed by class representatives in each participating department, who shared it with peers through departmental communication channels. Paper copies of the identical instrument were concurrently distributed and completed in person during in-class sessions across participating departments. Both modes used identical question wording, item order, and response scales, so responses from the two modes were pooled for analysis; mode of administration was not analyzed as a separate variable.

2.5 Data Analysis Process

Data were analyzed using Python (pandas and SciPy libraries). Independent-samples t-tests (with Welch's correction for unequal variances) were used to test for cohort differences in awareness, attitude, and behavior (H1-H3); Pearson correlation analysis was used to test the relationships among awareness, attitude, and behavior (H4-H5); and Cronbach's alpha was used to assess the internal consistency of each scale.

For each independent-samples t-test, effect sizes are reported as Cohen's d, and 95% confidence intervals for the mean difference were derived from the reported t-statistic and degrees of freedom. For each Pearson correlation, 95% confidence intervals were derived using the Fisher z-transformation. These intervals are reported alongside the corresponding test statistics in the Results section below.

2.6 Ethical Considerations

This study upheld standard ethical research practices. The purpose of the study was explained to participants prior to their participation, and they took part voluntarily. Consent was obtained prior to data collection. The questionnaire did not collect any personally identifiable

information, and anonymity and confidentiality were maintained throughout. Participants were free to withdraw from the survey at any point without consequence. The study was conducted under the institution's ethical research framework and posed no risk to participants.

3. Results

This study investigates the relationship between EE and the knowledge, attitude and sustainable practices of undergraduate students. Two groups, the Target Cohort (students from Forestry and Environmental Science, and from Geography and Environmental Studies), and the General Cohort (students from academic disciplines outside of the environmental sciences) were compared in this analysis using descriptive statistics, comparative mean scores, and inferential testing (based on responses to a structured survey instrument).

3.1 Demographic Overview

202 undergraduate students completed the survey; 6 were not included in the analyses because they did not meet the survey inclusion criteria, resulting in 196 valid responses to the survey. It was an interdisciplinary study involving participants from 28 departments/institutes.

Academic Discipline Distribution: Target Cohort (environmental disciplines) 23.98%; General Cohort (other disciplines) 76.02%.

Gender Distribution: Male 55.10%; Female 44.90%.

Environmental topics in curriculum: 51.53% of students indicated that they had them in their curriculum and 48.47% indicated they did not.

3.2 Environmental Awareness Assessment

Conceptual awareness was assessed for two groups: Target Cohort (n = 47) and General Cohort (n = 149) with 11 key environmental terms each sorted into 3 levels: High Awareness (can define), Moderate Awareness (recognizes but can't define), and Low Awareness (never heard of the term).

Figure 1 demonstrates the familiarity with environmental terms of the Target Cohort. Full conceptual understanding (100%) was found for Ecosystem, Greenhouse effect, Ozone layer, Deforestation, Climate change and Global warming. The understanding was near complete for Carbon footprint (91.49%), Biodiversity (97.87%) and Soil erosion (97.87%) and minor gaps were present for Flora and fauna (89.36% could define) and Aquifer (87.23% could define; 12.77% recognized but could not define). The overall results show very good knowledge of the environmental vocabulary in the Target Cohort, and the minor weaknesses found do not significantly impact the overall competency level.

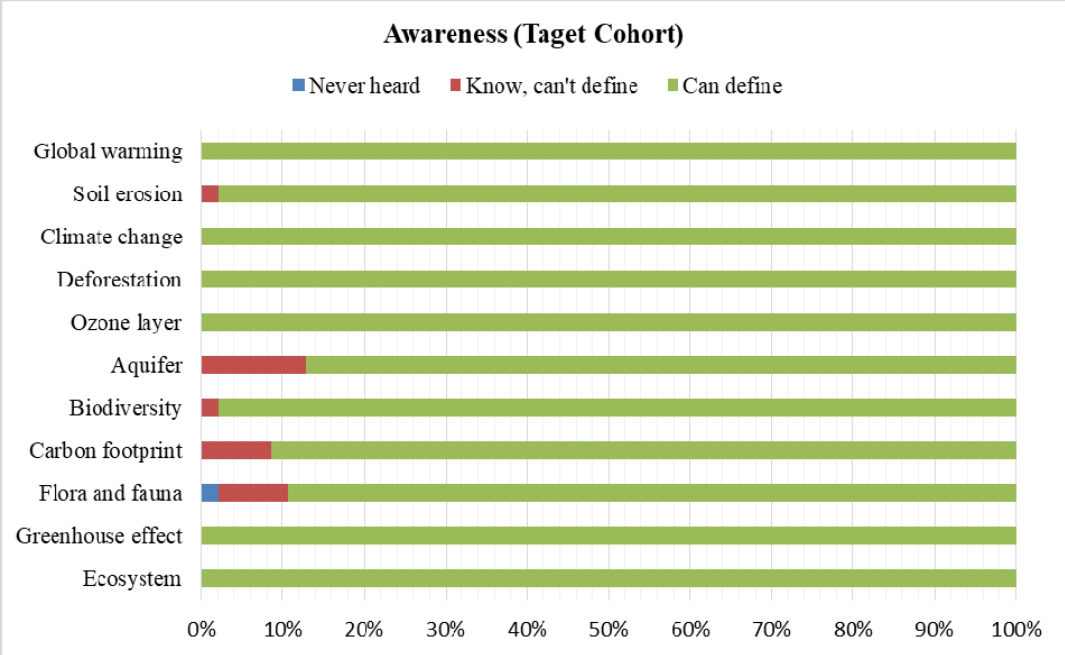

Figure 1. Awareness of key environmental terms in the Target Cohort

Note. The x-axis is the percentage of responses in each awareness category: never heard of the word (blue), know the word but cannot define it (orange), and can define it (green). The y-axis lists the 11 environmental terms assessed.

In the General Cohort, there was more variation in the environment knowledge (Figure 2). High familiarity (approximately 80% or higher) was recorded for Deforestation (95.97%), Climate change (95.97%), Global warming (94.63%), Ecosystem (83.89%), Biodiversity (79.19%), and Soil erosion (79.87%). Ozone layer had moderate familiarity (40-70%) and Carbon footprint was also recorded with moderate familiarity (39.60%). Larger gaps were found for Aquifer (61.74% had never heard of the term, and only 19.46% could define it) and Flora and fauna (42.28% had never heard of the term; only 18.79% could define). This pattern is indicative of a stronger dependence of the General Cohort on media and informal learning, where they are much more familiar with the terms that have been widely discussed in the news than with the more technical ecological and hydrological terms.

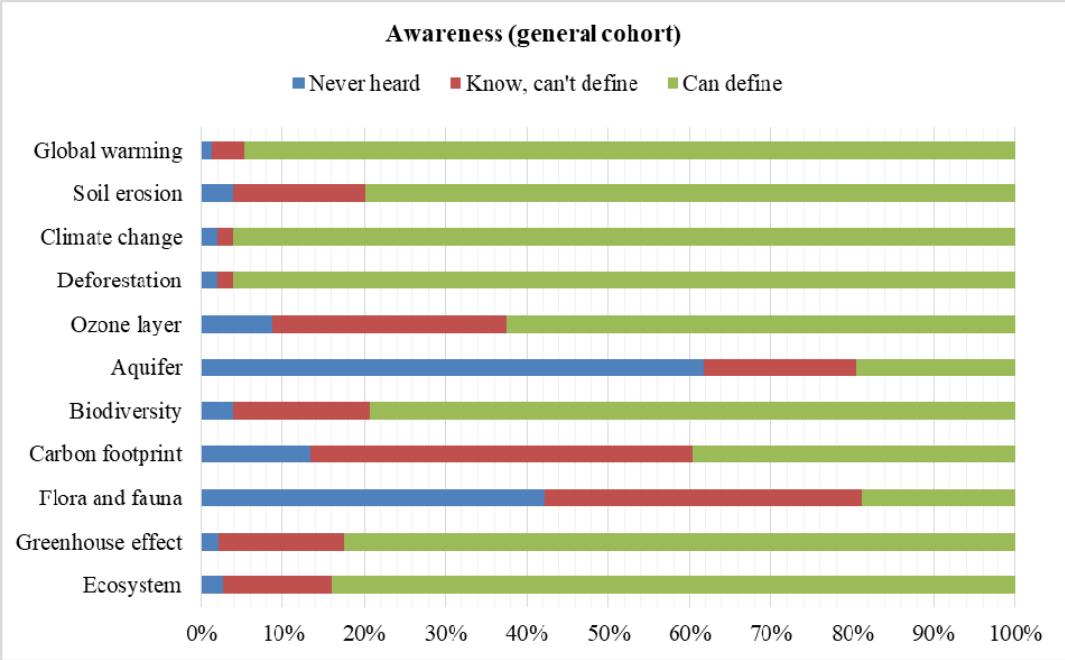

Figure 2. Awareness of key environmental terms in the General Cohort

Note. The x-axis is the percentage of responses in each awareness category: never heard of the word (blue), know the word but cannot define it (orange), and can define it (green). The y-axis lists the same 11 environmental terms as Figure 1.

To formally test H1, an independent-samples t-test (Welch-corrected) was used to compare the composite awareness scores (mean of the 11 terminology items, scored 1-3) between the cohorts. The Target Cohort scored significantly higher than the General Cohort, $t(185.7) = 15.55$, $p < 0.001$, 95% CI for the mean difference [0.37, 0.47], Cohen's $d = 1.57$ (a very large effect). The existence of H1 is supported: Environmental education has positive relationship with environmental awareness.

3.3 Comparative Analysis of Awareness Patterns

There are three patterns when comparing the cohorts. The universally recognized terms (climate change, global warming, and deforestation) have the least differences across cohorts, at under 5%, probably because they are common in both mass media and in the public discourse. For the discipline terms (aquifer, flora and fauna), the gaps between cohorts are around 60-70%, suggesting that these are terms that need to be taught formally to be understood well. Intermediate terms (carbon footprint, ozone layer) demonstrate common knowledge gaps of between 30-50%, indicating a certain diffusion into common knowledge but not as intensive as structured training.

3.4 Environmental Attitudes Evaluation

A 5 point/Likert scale (1 = Strongly Disagree, 5 = Strongly Agree) was used to gauge

attitudes toward the environment. There is significant variation in scores between cohorts (Figure 3).

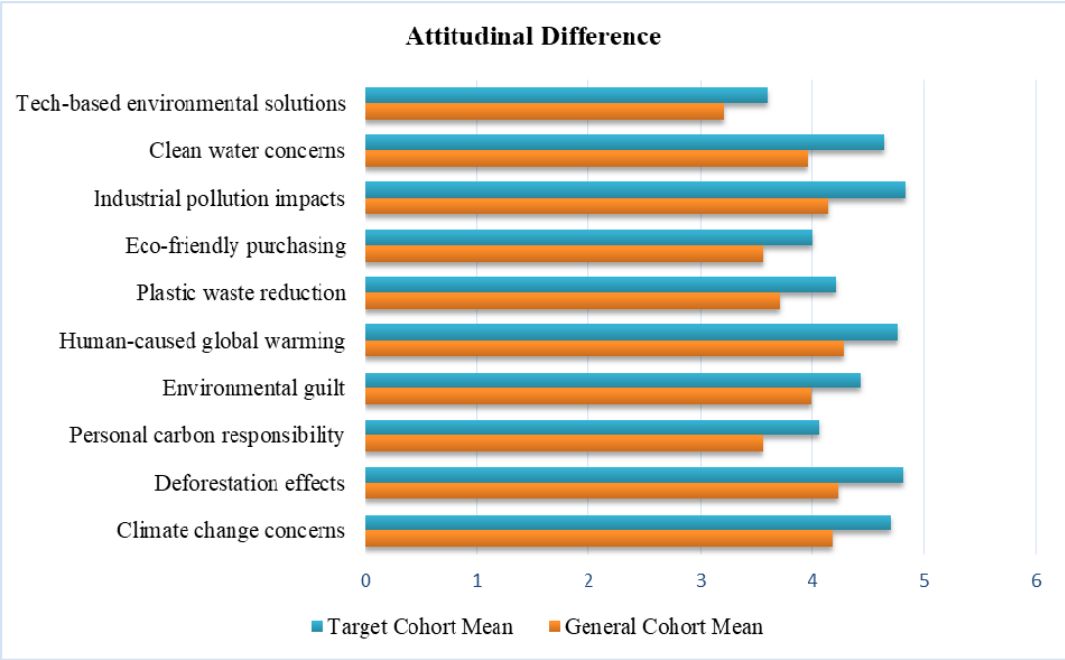

Figure 3. Attitudinal differences between cohorts across environmental concerns

Note. The x-axis shows the mean attitude score (0.00-5.00, 1 = Strongly Disagree, 5 = Strongly Agree). The y-axis lists selected environmental concern items.

The overall mean score of the responses to the question of attitude of the Target Cohort participants toward the environment was 4.40 out of 5. Industrial pollution (M = 4.83), deforestation effects (M = 4.81), human-caused global warming (M = 4.77), climate change effects (M = 4.70), and clean water availability (M = 4.64) were the top concerns. Overall, the General Cohort had moderately positive attitudes with an average score of 3.88. Their worries were fairly similar, except they were not as intense: global warming was the most salient concern (M = 4.28), followed by climate change (M = 4.18) and industrial pollution (M = 4.14).

Target Cohort students also expressed greater personal responsibility—environmental guilt (M = 4.43), plastic waste reduction (M = 4.21), personal carbon responsibility (M = 4.06) were rated highly, and so was the purchasing behaviour of the students (M = 4.00). The General Cohort had statistically significantly lower scores than the Target Cohort for two personal-responsibility items: personal carbon responsibility (3.55 - 0.51 point) and plastic waste reduction (3.71-0.50 point).

To formally test H2, an independent-samples t-test compared composite attitude scores (mean

of 10 items, scored 1-5) between cohorts. The Target Cohort reported significantly higher positive environmental attitudes than the General Cohort, $t(129.8) = 5.59$, $p < 0.001$, 95% CI for the mean difference [0.34, 0.71]; Cohen's $d = 0.73$ (a medium/large effect). H2 is supported.

3.5 Sustainable Behavioral Practices

Sustainable practices were measured on a 5-point scale (1 = Never, 5 = Always). Target Cohort pupils reported above average engagement—with their average mean engagement response being 3.65 out of 5. The most common behaviours that included daily conservation were: water-waste awareness (M = 4.57), household energy conservation (M = 4.21), and use of reusable water bottles (M = 4.19). A comparison of the General Cohort with the Target Cohort showed similar patterns of higher and lower mean scores for the same behaviors, with the General Cohort reporting a lower overall mean (3.28, a 0.37-point gap from the Target Cohort); indicating that, at a minimum, there is a level of sustainable practice even before students have environmental coursework. These patterns are illustrated in Figure 4.

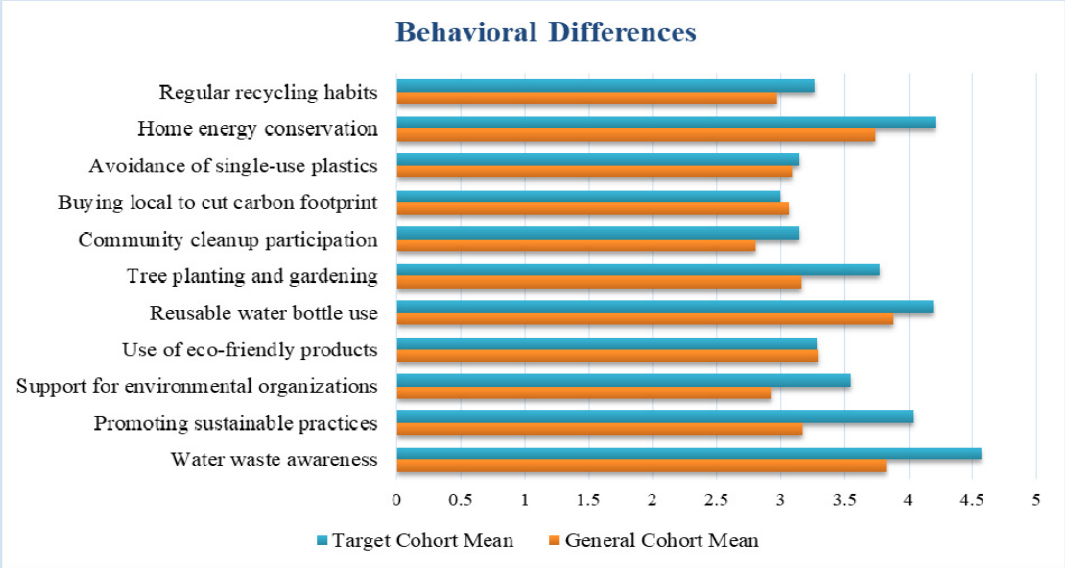

Figure 4. Behavioral differences between cohorts across sustainable practices

Note. The x-axis shows the mean behavior score (0.00-5.00, 1 = Never, 5 = Always). The y-axis lists the 11 sustainable-practice items assessed.

Data for the formal test of H3 were obtained using an independent-samples t-test for two cohorts on their composite scores on sustainable-behaviour (mean of 11 items scored 1-5). The Target Cohort reported significantly higher rates of sustainable behavior than the General Cohort $t(127.0) = 3.63$, $p < .001$, 95% CI for the mean difference [0.17, 0.57], Cohen's $d = 0.48$ (a small-to-medium effect). H3 is supported.

3.6 Behavioral Disparities Analysis

The qualitative pattern of the attitude-behavior gaps are summarized in Table 2 in relation to each of the practice types. The table is a description of the pattern of the 21 attitude and behaviour items, according to a thematic classification, and is not the result of a formal hypothesis testing.

Table 2. Differences in behaviour

Practice Type	**Attitude-Behavior Gap**	**Cohort Difference**
Individual Actions (*e.g.*, recycling)	Small (delta 0.2-0.3)	Minor
Community Engagement (clean-ups, education)	Large (delta 0.7-1.0)	Significant
Consumption Choices (eco-products, local food)	Moderate (delta 0.4-0.5)	Notable

Although the Target Cohort's scores were higher overall on both the attitude and the behavior scales, the scores for the General Cohort were more strongly related (r = 0.70) than were those for the Target Cohort (r = 0.56). The absolute difference between the mean attitude score (3.88) and the mean behavior score (3.28) was also larger in the General Cohort, with a difference of 0.60 points. The Target Cohort had more positive attitudes (13.5%) and more frequent sustainable practices (11.2%), and their behavior was more consistent (lower variance) toward them when they participated in EE.

3.7 Comparative Analysis: Target Cohort vs. General Cohort

For the details of the comparative analysis of Cohorts please refer to Table 3.

Table 3. The comparative analysis of Cohorts

Aspect	**Target Cohort (Mean)**	**General Cohort (Mean)**	**Difference**
Awareness (Definition Accuracy, 1-3 scale)	2.97	2.55	+0.42
Attitude (Environmental Concern, 1-5 scale)	4.40	3.88	+0.52
Behavior (Sustainable Actions, 1-5 scale)	3.65	3.28	+0.37

This pattern has shown that although there is an association between EE and EE awareness, positive attitudes, and sustainable behaviors in the Target Cohort, the association is lower on the General Cohort in respect to EE in terms of EEs behaviours and lower in respect to EE in terms of positive attitudes.

Pearson correlation analysis was performed on the entire sample (N = 196) for H4 and H5. In

line with H4, sustainable behavior was significantly positively correlated with environmental awareness scores ($r(194) = .33$, $p < 0.001$; 95% CI [0.20, 0.45]). Sustainable behavior was more strongly associated with environmental attitude, $r(194) = 0.70$, $p < 0.001$, 95% CI [0.62, 0.77] supporting H5. Both associations remained positive and significant within the Target Cohort (awareness-behavior $r = 0.33$, $p = 0.025$, 95% CI [0.05, 0.56]; attitude-behavior $r = 0.56$, $p < 0.001$, 95% CI [0.33, 0.73]) and the General Cohort (awareness-behavior $r = 0.27$, $p < 0.001$, 95% CI [0.11, 0.41]; attitude-behavior $r = 0.70$, $p < 0.001$, 95% CI [0.61, 0.77]).

4. Discussion

This study's findings contribute to understanding the relationship between the Knowledge-Attitude-Behavior (KAB) pathways with undergraduate students with respect to specialized EE. The academic exposure is correlated with higher environmental literacy and more frequent sustainable behavior, and a gap between environmentally oriented values and sustainable behaviors exists in both the Target Cohort (environmental disciplines) and the General Cohort (non-environmental disciplines).

4.1 Environmental Literacy Gap: Technical vs. General Awareness

Significant differences between the number of formal curricula and mass-media terms in the technical vocabulary, as opposed to those in high-profile vocabulary, indicate that mass-media exposure and formal curricula play different roles in the construction of knowledge: mass-media exposure seems to build up recognition of issues that appear in the headlines, and formal curricula seem to build up the deeper conceptual terminology needed for reasoning about ecological systems. This is consistent with previous results showing that formal EE education provides opportunities to attain conceptual depth that is not found in informal education settings (Eugenio-Gozalbo et al., 2020; Monroe et al., 2019) but cannot confirm that EE courses create this gap, given that the study was cross-sectional and students who self-selected into EE courses were more interested in EE in the first place.

4.2 Personal Responsibility, Environmental Attitudes and Perception

There was also a significant difference among groups in the intensity of attitudes. The attitudes of both groups towards environmental protection were generally positive, with Target Cohort students showing significantly higher levels of both urgency and personal responsibility. Their high scores on personal carbon responsibility and lifestyle-related items are in line with previous research that has shown that EE can contribute to an increase in environmental identity and feelings of personal responsibility (Clayton, 2012; Kollmuss & Agyeman, 2002). In contrast, students in the General Cohort seemed more inclined to think of environmental issues as a technological or governmental problem rather than something that requires their own personal responsibility, which has been described in the literature as diffusion of responsibility, or a lack of individual sense of responsibility to address environmental issues (Gifford, 2011).

4.3 Patterns of Behavior: Everyday Actions vs. Systemic Engagement

For both cohorts, the level of engagement in low effort, high visibility actions was high, and

aligned with the literature on low effort, high benefit actions (Steg & Vlek, 2009). In both groups, more challenging or group-based activities, like community organizing or advocacy, were not as prevalent. This implies that, while awareness and positive attitudes could help in simple behavior change, more significant behaviors may need other motivational, institutional or structural support in addition to awareness and positive attitude.

4.4 The Value-Action Gap

Attitude to behavior scores (Section 3.7) decreased in both cohorts, and the decrease was numerically greater, albeit somewhat counter intuitively, in the Target Cohort than in the General Cohort, even if the scores for both measures were higher for the Target Cohort. The pattern indicates that formal EE doesn't necessarily lower the gap between concern and action; those who know and care the most are not necessarily those whose actions are most concordant with their attitudes.

This picture is complicated by correlational results: the relationship between attitude and behavior was greater in the General Cohort than in the Target Cohort (Section 3.7), but the relationship between individual variation in environmental concern and individual variation in sustainable behavior was stronger among General Cohort students, although overall levels of behavior remained lower. This indicates that a greater overall level of sustainable behaviour is linked to specialized EE, but this does not necessarily strengthen the link between the strength of the attitude and sustainable behaviour, as other factors such as perceived behavioural control, opportunity structures, and social norms may be more important in bridging the gap between attitude strength and consistent behaviour than attitude strength alone (Kollmuss & Agyeman, 2002; Bamberg & Moser, 2007).

4.5 Implications education and behavioral inequality

Put together, these findings support the idea that there are measurable differences in environmental attitudes and sustainable behaviour between university students with and without EE and that these differences are associated with EE, but do not constitute evidence that this coursework causes the difference. The differences between the levels of environmental involvement in the community of the various cohorts were one of the larger differences found and suggest a specific area (collective, not individual environmental action) where general education exposure seems most inadequate by itself.

The need for experiential learning, the integration of disciplines, and the involvement of communities in fostering environmental citizenship among university students has been highlighted in previous studies (Wals, 2014; UNESCO, 2020). In addition to incorporating environmental education content in science and related programs, universities should strive to integrate environmental content into a broader spectrum of disciplines and to provide opportunities for hands-on, collaborative learning experiences in the real world, rather than limiting EE to science classes.

5. Limitations

There are a number of caveats about these findings. First, the Target and General Cohorts

were not selected by random sampling, but rather by purposive sampling, including selecting participants whose department was either categorized under a certain environmental or non-environmental category, and for the General Cohort selecting respondents by convenience access through class representatives instead of a systematic probability sample. This could also suggest that there are differences between the two cohorts and the student population in general that are related to the outcome variables measured; for example, students who volunteered to take part in the survey may be more civically engaged and more environmentally interested than students who did not take part, and this difference would strengthen the apparent relationship between the variables. Cohort differences reported here may not be attributed solely to environmental disciplines since they may have been the result of self-selection into these disciplines by students who were already more environmentally engaged prior to entering the course.

Second, the three outcome measures (awareness, attitude, and sustainable behavior) were completely self-reported. Social desirability bias was possible regarding self-reported behavior, particularly because the participants knew the goal of the survey from the survey content, the participants were well-aware that they were expected to model sustainable behaviors, and participants of environmental disciplines might feel more pressure to act in a sustainable way and thus over-report their sustainable behavior compared to other respondents. The awareness measure is also a self-assessed type of definitional knowledge, thus reflecting perceived, not tested, knowledge of each term. This may be partly responsible for the observed lower attitude-behaviour correlation in the Target Cohort, given that in the Target Cohort students were more likely to be clustered towards the ceiling when reporting their behaviour.

Thirdly, data were gathered at a single university in the district of Chattogram in Bangladesh. The content of the curriculum, institutional culture, environmental exposure of the region (*e.g.*, coastal and forest ecosystems) and the composition of the two departments of the Target Cohort are specific to this setting and may not be applicable to other institutions, regions or national settings. The results from this survey should be replicated across a number of universities, preferably with a greater geographical and institutional spread, before it can be generalized as a pattern of EE generally and not the characteristics of this institution.

Lastly, the cross-sectional design does not allow determining the temporal evolution or persistence of the observed associations, nor the direction of the associations (if they exist); thus, a longitudinal or quasi-experimental design would be required to explain the direction or persistence of observed associations or the effects of environmental coursework on awareness, attitude, and behavior.

The validation process of the instrument was also conducted limitedly, as only one expert reviewed the content, and the pilot test engaged in a small sample (n = 12) from the same university as the study population, which is not an external population. The instrument's psychometric properties would be enhanced in future iterations of this research with a broader expert panel and a larger and more diverse pilot sample, as well as formal construct-validity testing (*e.g.*, exploratory factor analysis).

6. Conclusion

Students in the environment-related disciplines in this one university, cross-sectional sample showed significantly higher environmental awareness and positive attitudes than students in other disciplines with effect sizes of small-to-medium (behaviour) to very large (awareness). These associations provide evidence that coursework and the observed differences may have partly been a self-selection by students who were already more environmentally engaged, and should therefore not be concluded as evidence that coursework causes the differences. To support stronger causal claims, either longitudinal or quasi-experimental designs might be needed, or replication across other institutions. With that proviso, the evidence from this study is congruent with a wider context of the importance of structured environmental curricula in influencing environmental knowledge and behavior, and provides initial policy support (not proof) for the integration of a wider range of environmental content into general curriculum settings for non-specialist students.

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Appendix A

Questionnaire

This questionnaire is designed for research purposes. Your feedback is invaluable in assessing the actual scenario. We sincerely appreciate your cooperation.

Participant's Department/Institute: _____

Session/Year: _____ Gender: _____

Does your curriculum include any environmental related courses? Ans: _____

Instruction: Please select the option that best describes your familiarity with the term (1 = I have never heard this word; 2 = I know the word, but cannot define; 3 = I can define)

Terms	1-Never heard	2-Know, cannot define	3-Can define
Ecosystem	1	2	3
Greenhouse effect	1	2	3
Flora and fauna	1	2	3
Carbon footprint	1	2	3
Biodiversity	1	2	3
Aquifer	1	2	3
Ozone layer	1	2	3
Deforestation	1	2	3
Climate change	1	2	3
Soil erosion	1	2	3
Global warming	1	2	3

Instruction: Please rate how strongly you disagree or agree with each of the following statements. (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree)

Statement	**1**	**2**	**3**	**4**	**5**
I am deeply concerned about the impacts of climate change.	1	2	3	4	5
I worry about the effects of deforestation on the planet.	1	2	3	4	5
I feel a personal responsibility to reduce my carbon footprint.	1	2	3	4	5
I feel guilty when I engage in behaviors that harm the environment.	1	2	3	4	5
I believe human activities are the primary cause of global warming.	1	2	3	4	5
Reducing plastic waste is an important goal for me.	1	2	3	4	5
I prioritize buying products that are environmentally friendly.	1	2	3	4	5
I am worried about the impact of industrial pollution on health and ecosystems.	1	2	3	4	5
I am concerned about the future availability of clean water.	1	2	3	4	5
I believe technology will provide solutions to most environmental problems.	1	2	3	4	5

Instruction: Please rate how strongly you disagree or agree with each of the following statements. (1 = Strongly disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly agree)

Statement	**1**	**2**	**3**	**4**	**5**
I regularly recycle paper, plastic, and glass.	1	2	3	4	5
I make an effort to conserve energy at home (*e.g.*, turning off lights and unplugging devices).	1	2	3	4	5
I avoid using single-use plastics.	1	2	3	4	5
I buy locally produced food to reduce my carbon footprint.	1	2	3	4	5
I participate in community clean-up events.	1	2	3	4	5
I plant trees or maintain a garden to support local ecosystems.	1	2	3	4	5
I use a reusable water bottle instead of buying bottled water.	1	2	3	4	5
I use eco-friendly products.	1	2	3	4	5
I support or donate to environmental organizations.	1	2	3	4	5
I educate others about sustainable practices.	1	2	3	4	5
I am always conscious about the wastage of water.	1	2	3	4	5

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Authors Contributions

Dr. Faozia Faleha Sadida was responsible for the overall conceptualization, methodology, research supervision, project administration, securing resources, validation, and reviewing and editing the manuscript. Mehedi Hasan Bulbul, under the supervision of Dr. Faozia Faleha Sadida, was responsible for the conceptualization, methodology, investigation, data curation, formal analysis, visualization, validation, and drafting the original manuscript. All authors read and approved the final manuscript.

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