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# The role of sustainability-integrated curricula in promoting sustainable practices among university students

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**ABSTRACT**

Universities promote student sustainability awareness, but the gap between attitudes and actual behaviours remains underexplored, particularly regarding curriculum influence. This study investigates the relationships between students' awareness of campus sustainability initiatives, their attitudes, and the adoption of sustainable behaviours, with particular emphasis on the influence of sustainability-integrated curricula. Specifically, the study examines (i) the relationship between awareness and attitudes, (ii) the extent to which positive attitudes translate into sustainable behaviours, and (iii) the impact of curriculum integration on awareness, attitudes, and behavioural adoption. A quantitative survey of 259 undergraduate students at Istanbul Gelisim University was analysed using correlation and regression techniques. The findings reveal a significant positive relationship between sustainability awareness and attitudes ($r = 0.62$, $p < 0.01$). However, an observable attitude–behaviour gap exists, as only 58% of students consistently translate positive attitudes into sustainable practices. Students exposed to sustainability-integrated curricula demonstrated higher levels of awareness ($M = 4.31$), attitudes ($M = 4.28$), and behaviours ($M = 4.05$). Regression results further indicate that curricular exposure significantly predicts sustainable behaviour ($\beta = 0.34$, $p < 0.01$). The findings underscore the importance of embedding sustainability within university curricula to strengthen sustainable actions among students.

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Sustainability awareness; attitude–behaviour gap; curriculum integration; higher education; sustainable behaviours

**SUBJECTS**
Sustainability Education; Training & Leadership; Higher Education; Higher Education Management; Education Policy

## 1. Introduction

Over the past decade, universities have increasingly been recognised as essential actors in advancing sustainable development not only through research and policy advocacy but also by shaping the behaviours and mindsets of future generations (Menon & Suresh, 2020; Selvakumar & Sivakumar, 2025; Tilbury, 2011). The modern concept of sustainable development (SD) emerged with the Brundtland Commission, which defined it as meeting the needs of the present without compromising the ability of future generations to meet their own needs (Borowy, 2021). Building on this, the 2030 Agenda, which was adopted in 2015, established 17 Sustainable Development Goals (SDGs) that tackle pressing global issues like eradicating poverty, mitigating the effects of climate change, protecting the environment and pursuing equitable societies (Bexell & Jönsson, 2017; Mora et al., 2020).

Within this global framework, Higher Education Institutions (HEIs) are recognised as major drivers of sustainability. They are expected to integrate sustainability into curricula and research, act as regional hubs for knowledge transfer and embed sustainable principles into their governance structures and strategies (Menon & Suresh, 2020; Trevisan et al., 2024). In doing so, HEIs fulfil a dual role: producing knowledge while equipping students with the skills and competencies needed to act as future leaders in sustainable societies (Bakar et al., 2024). This positions universities as both educators and transformative agents of societal change. This obligation has been reaffirmed by international declarations and actions. Sustainability in higher education has grown in importance since the

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Brundtland Commission (1987), Agenda 21 of the Rio Conference, the Thessaloniki Declaration (United Nations Educational and Scientific and Cultural Organisation (UNESCO), 2020) and the World Summit on Sustainable Development (United Nations Environment Programme (UNEP), 2002). Academic institutions' dedication to integrating sustainability concepts into research, teaching and campus management is further demonstrated by the Declaration (1990), which was signed by hundreds of universities worldwide.

Incorporating sustainability into higher education in Turkey has presented both opportunities and challenges due to the country's universities' explosive growth over the last 20 years. National programmes, such as the Zero Trash Project, started in 2017 under the aegis of the First Lady, aim to encourage trash reduction and environmental awareness in connection with the UN Sustainable Development Goals. Similar to this, the Council of Higher Education (YÖK) in Turkey has implemented 'Green and Climate-Friendly Campus' initiatives to promote energy efficiency, sustainable practices and the use of renewable energy in Turkish universities (Council of Higher Education, 2023). Research on students' attitudes, behaviours and perceptions of sustainable campus activities is still scarce, despite these increasing institutional commitments. Examining these viewpoints adds to comparative international scholarship on sustainability in higher education and offers insightful information for policy development, especially in the light of Istanbul Gelisim University's sustainability drives across multiple institutional organs (Agboola et al., 2025; Mora et al., 2020).

Embedding sustainability principles into campus operations, learning environments and student engagement programmes has been widely recognised as an effective strategy for fostering environmentally responsible behaviours among higher education students (Filho et al., 2024; Jalaludin, 2025; Trevisan et al., 2024). Campus-based initiatives such as energy conservation campaigns, waste minimisation programmes and the integration of green infrastructure function as living laboratories where students can translate sustainability knowledge into practical action, thereby strengthening experiential learning and civic responsibility. However, the effectiveness of such initiatives depends not merely on their availability but on students' levels of motivation, knowledge and active engagement.

Recent empirical studies underscore that the development of sustainability competencies is strongly influenced by the interplay between students' attitudes, perceived relevance and participatory learning opportunities. Núñez et al. (2024) and Nejati and Nejati (2013) demonstrated that motivation and sustainability-related knowledge significantly predict student engagement and the acquisition of sustainability competencies, suggesting that passive exposure to sustainability messaging is insufficient to drive behavioural change. Similarly, Santillán et al. (2023) showed that collaborative and interactive learning environments, particularly those that encourage cross-cultural and problem-based engagement, enhance students' commitment to sustainability goals and deepen behavioural intention. Despite generally positive attitudes towards sustainability among university students, the persistent attitude–behaviour gap remains a critical challenge. While awareness and favourable perceptions of sustainability practices can influence attitudes, they do not automatically result in consistent pro-sustainability actions (Kollmuss & Agyeman, 2002; Null & Asirvatham, 2023). This gap highlights the need for university policies and programmes that move beyond awareness-raising to actively cultivate engagement, agency, and accountability. Consequently, sustainability initiatives must be intentionally designed to integrate behavioural feedback mechanisms, participatory learning models, and institutional support structures that enable students to consistently align attitudes with sustainable practices.

Furthermore, the role of sustainability-integrated curricula in bridging this gap has received limited empirical attention. How formal educational interventions might improve attitudes and real behaviours is still up for debate (Barth & Rieckmann, 2012; Plietzsch et al., 2026). Although students' awareness and attitudes regarding sustainability have been studied in the past, few studies have looked at how these beliefs are translated into action on campus. The attitude–behaviour gap's continued existence raises the possibility that awareness by itself would not be enough to promote sustainable habits (Alkhayyal et al., 2019; Kollmuss & Agyeman, 2002). Similarly, there is still a dearth of empirical research on courses or modules that integrate sustainability principles across disciplines, especially when it comes to their impact on university students' adoption of bridging awareness, attitudes and behaviours.

By investigating the connections between students' knowledge of sustainable campus initiatives, their attitudes towards sustainability and their participation in sustainable behaviours with an emphasis on

the moderating influence of sustainability-integrated curricula, this study aims to close these gaps. The study's objectives include:

1. examining the connection between sustainability attitudes and awareness;
2. assessing how well positive attitudes translate into sustainable behaviours and
3. evaluating how sustainability-integrated curricula affect awareness, attitudes, and behavioural adoption.

The following hypotheses are tested in this study:

H1**:** Sustainability attitudes are favourably predicted by awareness.

H2: Consistent, sustainable behaviours are not necessarily a direct result of favourable attitudes;

H3: Students' awareness, attitudes and sustainable behaviours are improved when they are exposed to a curriculum that incorporates sustainability.

The findings demonstrate the persistence of the attitude–behaviour gap, which continues to be a major obstacle in promoting sustainable practices, while also highlighting the need to fortify the awareness–attitude link. This study offers context-specific insights that enhance international discussions on education for sustainable development since it is situated in Turkey, a nation with a distinctive sociocultural location that bridges Europe and Asia. Ultimately, the study contributes to understanding how sustainability-integrated curricula can foster more consistent awareness, attitudes and behavioural adoption among students. The remainder of the study is organised into five sections. Section 1 gives a brief background of the study; Section 2 reviews the literature and expounds on the conceptual framework of the study and develops its research hypotheses. Section 3 discusses the research method, including data collection instruments, measurement and data analysis. Section 4 presents the results and discussion; the last Section 5 gives the conclusions and policy implications.

## 2. Relevant literature, theory and hypotheses development

### *2.1. Sustainability in higher education: awareness, attitudes, behaviour and curriculum integration*

Marking the 20th anniversary of the Tbilisi Doctrine and responding to the need to reassess sustainability education for the twenty-first century, the International Conference held in Thessaloniki in December 1997 culminated in the adoption of the Thessaloniki Declaration (Knapp, 2000). Although the Declaration explicitly referenced 'environmental education' only twice across its 29 statements, its broader significance lay in reframing sustainability as an integrated educational mandate encompassing environmental, social, economic and governance dimensions. This shift provided a foundational policy rationale for embedding sustainability principles within higher education systems, aligning institutional missions with emerging national and international sustainability agendas.

In this context, universities have increasingly been recognised as strategic policy actors capable of translating global sustainability frameworks into actionable institutional policies and practices (Borowy, 2021; Filho et al., 2024; Lozano et al., 2015; Trevisan et al., 2024). Through curriculum reform, research prioritisation, campus operations and community engagement, higher education institutions operationalise national sustainability objectives while fostering innovation and behavioural change. Beyond their instructional role, universities shape the values, attitudes and decision-making capacities of students who will influence future policy, industry and governance systems (Ankareddy et al., 2025; Menon & Suresh, 2020; Tilbury, 2011). Campus-based sustainability initiatives such as energy efficiency programmes, waste reduction policies, green infrastructure development and student-led environmental projects serve as living laboratories that reinforce institutional sustainability policies while supporting national low-carbon and resource-efficiency goals. These initiatives provide experiential learning environments that promote active engagement, behavioural transformation and long-term commitment to sustainable development (Hopkins & McKeown, 2002; Mittal & Bansal, 2024).

Sustainability in higher education institutions (HEIs) demands interdisciplinary and transdisciplinary strategies to sustainability and behaviours, as shown in Figure 1. Universities are responding by embedding sustainability into existing courses or offering new programmes, thereby equipping students with industry-relevant skills and fostering social responsibility (Ankareddy et al., 2025; Tasdemir & Gazo, 2020). In a similar vein, over time, research and development (R&D) play a central role in advancing sustainable innovations and achieving climate targets, with outcomes mapped to relevant SDGs. Collaboration between universities and companies improves this process by integrating many scientific disciplines and striking a balance between basic and applied research, claimed by Sarpong (2022) and Bashir et al. (2023). According to Saoualih et al. (2025), campuses themselves function as 'living laboratories' where eco-friendly transportation, waste minimisation and green infrastructure may all be used to illustrate sustainability. Importantly, student participation is essential to the success of these programmes. The effectiveness of bottom-up strategies is demonstrated by the fact that student-led initiatives frequently quicken transitions through behavioural changes, policy advocacy, education, campus greening and energy conservation measures (Biancardi et al., 2023; Lozano et al., 2013).

According to research, students who receive structured sustainability education outperform their peers in terms of engagement, pro-environmental attitudes and adoption of sustainable behaviours (Ankareddy et al., 2025; Barth & Rieckmann, 2012; Filho et al., 2024). Through practical, practice-oriented learning that integrates sustainability principles across disciplines, awareness and attitude change are encouraged, making it easier for people to adopt new behaviours (Barth & Rieckmann, 2012; Lozano et al., 2015; Menon & Suresh, 2020). Higher environmental literacy and a greater dedication to pro-sustainability behaviours are demonstrated by students enrolled in sustainability-integrated curriculum (Mora et al., 2020; Plietzsch et al., 2026; Wals, 2014). Curriculum designs that incorporate project-based learning, interdisciplinary learning and problem-solving techniques improve students' capacity to translate sustainability ideals into tangible actions.

The sequential process of transforming sustainability knowledge into actionable behaviours is quite important. The awareness forms the foundation for shaping positive attitudes, while these attitudes, when supported by curriculum integration as a strategic tool, facilitate the adoption of **s**ustainable behaviours, the ultimate goal of sustainability education (Avelar et al., 2025; Jalaludin, 2025). Meanwhile, the progressive and interconnected nature of learning, attitude formation and practical behavioural change could not be overemphasised. In the same vein, Table 1 presents reviews of literature on various insights highlighting the critical role of higher education institutions in shaping sustainable behaviours. They underscore the importance of simultaneously fostering awareness, cultivating positive attitudes and embedding sustainability into curricula to bridge the attitude–behaviour gap. The current study, which empirically explores the connections between awareness, attitudes and behaviours while analysing the

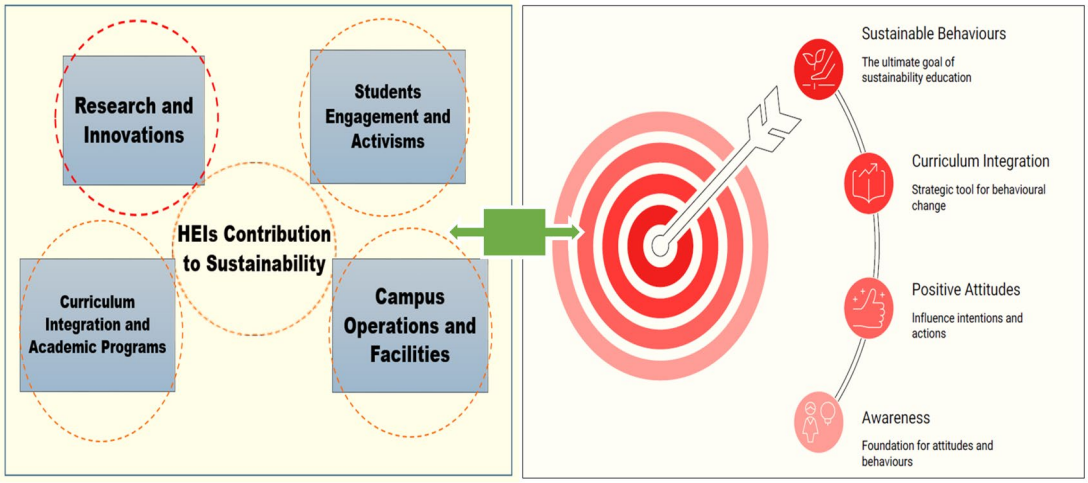



**Figure 1.** Frameworks illustrating higher education contribution to sustainability and behaviours. Source: Authors' conceptualisation.

**Table 1.** Literature review on environmental knowledge, perceptions and curriculum integration in sustainability education.

| Theme | Author(s) & year | Context / sample | Focus / variable | Key findings | Relevance to sustainability education |
|---|---|---|---|---|---|
| **1.** Historical Trends in Environmental Knowledge & Attitudes. | Thompson and Gasteiger (1985); Thapa (2001). | University students. | Environmental knowledge and attitudes (1971 vs. 1981). | Students in 1981 showed a more materialistic lifestyle and less environmental concern than in 1971. | Highlights historical trends in student environmental awareness. |
| | Alkhayyal et al. (2019); Nejati and Nejati (2013) | University students (Business & Arts/Sciences). | Environmental knowledge and attitudes. | All university faculties, including administration, lag behind the corporate level of environmental awareness. | Emphasises the need for cross-faculty sustainability integration. |
| | Borowy (2021); Mora et al., 2020 | Secondary school teachers. | Environmental knowledge and attitudes. | Teachers had poor knowledge but positive attitudes; they emphasised the need for environmental education in curricula. | Supports curriculum-based interventions for sustainable development in developing countries. |
| | Zimmerman and Weible (2017). | Undergraduate students. | Population, consumption, environmental impact. | Education should link population, consumption, and environmental quality; emphasise individual action and local issues. | Demonstrates the need for context-specific sustainability education. |
| **2.** Curriculum Integration & Sustainability Education. | Filho et al. (2024); Ankareddy et al. (2025). | University students training to teach science. | Curriculum planning for sustainability education. | Curriculum should integrate sustainability principles to prepare future teachers. | Provides a framework for embedding sustainability into curricula. |
| | Trevisan et al. (2024); Zsóka et al. (2013). | Universities globally. | Universities' role in sustainability. | Universities recognised the importance of including sustainability in curricula. | Reinforces institutional responsibility in sustainability education. |
| | Trevisan et al. (2024); Nejati and Nejati (2013) | Universities globally. | Universities' role in research, teaching, and community engagement. | Universities can lead in preventing ecological collapse; curriculum integration is key. | Highlights a holistic approach to sustainable campus development. |
| | Menon and Suresh (2020). | General educational context. | Contributions of disciplines and teachers. | Identifying current contributions of programmes and teachers is crucial for sustainability progress. | Guides curriculum evaluation and integration efforts. |
| | Barth and Rieckmann (2012); Mora et al. (2020) | Universities. | Sustainability-integrated curricula. | Enhances students' knowledge, fosters positive attitudes, and facilitates pro-environmental behaviours. | Shows curriculum as a moderator bridging awareness, attitude, and behaviour. |
| | Filho et al. (2024); Ankareddy et al. (2025). | Universities. | Curriculum integration & experiential learning. | Structured knowledge acquisition and practice-based activities strengthen the link between awareness, attitudes, and behaviours. | Highlights practical strategies for curriculum-based sustainability adoption. |
| **3.** Factors Influencing Students' Perceptions & Behaviour. | Loughland and Meyenn (2003); Leaper (2014). Lozano et al. (2013) | Young students | Gender difference & environment-related courses. | Girls are more likely than boys to have a 'relation' conception of the environment, linked to socialisation.<br>Girls are more environmentally conscious and active than boys.<br>Girls show stronger feelings and verbal commitment; boys have greater factual knowledge. | Suggests curriculum design should consider gender differences in environmental perception.<br>Supports targeted awareness interventions in the curriculum.<br>Emphasises the role of affective vs. cognitive learning in sustainability education. |
| | Jalaludin (2025); Mora et al. (2020) | Graduate-level course. | Interdisciplinary sustainability education. | Education can significantly influence sustainable daily behaviours (ecological footprint analysis). | Demonstrates the effectiveness of curriculum-based experiential learning. |
| | Gamage et al. (2022); Zsóka et al. (2013). | Developing countries. | Integration of sustainability principles. | Embedding sustainability into policies and education is crucial. | Provides global policy rationale for sustainability curricula. |
| | Oral et al. (2021)<br>Yapici et al. (2017). | Turkish university students. | Students' perceptions of environmental issues. | Understanding perceptions is the first step to integrating sustainability into education strategies. | Provides localised context for sustainable campus initiatives. |

*Source:* Authors' compilations.

effect of curriculum integration on sustainability outcomes in higher education, is based on an integrated perspective.

### 2.2. Theory of planned behaviour (TPB)

This study is grounded in the theory of planned behaviour (TPB), which conceptualises human behaviour as the outcome of behavioural intentions shaped by attitudes, subjective norms and perceived behavioural control (Ajzen, 2020; Conner, 2020). Within sustainability research, TPB has been widely applied to explain why individuals with positive environmental attitudes may still fail to engage consistently in pro-sustainability behaviours. Empirical evidence confirms that while awareness and favourable attitudes are often present, a persistent attitude–behaviour gap remains, driven by constraints such as convenience, perceived effort, limited control and institutional barriers (Bamberg & Möser, 2007; Null & Asirvatham, 2023). In higher education contexts, students may recognise the importance of sustainability initiatives yet refrain from active participation due to competing priorities, lack of enabling infrastructure or insufficient behavioural reinforcement mechanisms (Alkhayyal et al., 2019; Kalbarczyk et al., 2021).

Complementing TPB, this study also draws on the awareness–attitude–behaviour (AAB) model, which proposes that sustainability knowledge informs attitudes, which subsequently influence behavioural intentions and practices (Kollmuss & Agyeman, 2002). While the AAB model offers valuable insight into the cognitive and emotional pathways underlying environmentally responsible behaviour, empirical research demonstrates that this progression is rarely linear. External factors such as social norms, perceived behavioural control and availability of practical opportunities frequently disrupt the translation of positive attitudes into concrete action (Stern, 2000; Trevisan et al., 2024). These behavioural frameworks are particularly relevant within the context of higher education institutions (HEIs), which are increasingly recognised as critical agents in advancing Education for Sustainable Development (ESD) and responding to the United Nations'2030 Agenda for Sustainable Development.

HEIs have formally committed to embedding sustainability across teaching, research, governance and external leadership, positioning themselves as enablers of the Sustainable Development Goals (SDGs) of particular relevance is SDG-4 (Quality Education), especially Target 4.7, which emphasises ESD and global citizenship by equipping students with the knowledge, skills and values needed to address sustainability challenges by 2030 (UNESCO, 2023). However, aligning institutional commitments with student behaviour requires intentional policy design that enhances perceived behavioural control, reinforces social norms and provides actionable opportunities for engagement. Integrating TPB and AAB within this policy context, therefore, enables a more nuanced understanding of how universities can move beyond awareness-raising towards sustained pro-sustainability behaviour among students.

### 2.3. Hypotheses development

Understanding how sustainability awareness is translated into meaningful action remains a critical challenge within higher education. While students increasingly demonstrate high levels of environmental awareness and positive attitudes towards sustainability, these attributes do not always result in consistent pro-environmental behaviours. This discrepancy highlights the limitations of linear behaviour models and underscores the importance of identifying mechanisms that strengthen the link between knowledge, attitudes and action. Drawing on the AAB framework, this study examines the interrelationships between students' sustainability awareness, attitudes and behaviours, while introducing curriculum integration as a moderating factor. By embedding sustainability principles into academic programmes, universities can enhance experiential learning, reinforce environmental values and provide practical opportunities for behavioural adoption. Accordingly, the following hypotheses are proposed to empirically test these relationships and assess the role of curriculum integration in mitigating the attitude–behaviour gap. The current study uses curriculum integration as a moderating factor to increase the connections within the AAB model framework in order to overcome some limitations. The study is built upon three key assumptions: 1**).** higher awareness of sustainability initiatives leads to more positive attitudes among students; 2). positive attitudes do not necessarily guarantee consistent adoption of sustainable behaviours; 3).

curriculum integration strengthens each link in the AAB model, increasing the likelihood that awareness and attitudes are effectively translated into behavioural adoption. These assumptions underpin the study's three hypotheses.

#### *2.3.1. Hypothesis H1: awareness positively predicts attitudes towards sustainability*

This hypothesis is grounded in the AAB model and the cognitive–affective approach, which posit that knowledge and understanding of sustainability issues shape individuals' value orientations and evaluative judgments. In higher education contexts, students who are more informed about environmental challenges and institutional sustainability initiatives are more likely to develop favourable attitudes towards environmental responsibility. Empirical studies confirm that increased awareness enhances pro-environmental values, ethical concern and personal relevance of sustainability (Handoyo et al., 2021; Negm, 2024). Similarly, knowledge of campus-based sustainability initiatives has been shown to positively influence students' attitudes by reinforcing sustainability as both a personal and institutional priority (Alkhayyal et al., 2019; Jalaludin, 2025). Accordingly, this study hypothesises that higher levels of sustainability awareness among students will significantly and positively predict their attitudes towards sustainability.

#### *2.3.2. Hypothesis H2: positive attitudes do not always translate into sustainable behaviours*

Despite the presence of positive attitudes, behavioural adoption remains inconsistent, a phenomenon widely described as the attitude–behaviour gap. Prior research indicates that favourable sustainability attitudes do not automatically result in corresponding actions, such as recycling, energy conservation or sustainable mobility choices (Jalaludin, 2025; Kollmuss & Agyeman, 2002). Structural and contextual barriers, including limited institutional support, inadequate incentives, time constraints and lack of enabling infrastructure, often inhibit the translation of attitudes into behaviour (Kalbarczyk et al., 2021). In university settings, students may express strong environmental concern yet fail to engage in sustainable practices due to these external constraints. Therefore, this study hypothesises that positive attitudes alone are insufficient to guarantee the consistent adoption of sustainable behaviours.

#### *2.3.3. Hypothesis H3: curriculum integration enhances awareness, attitudes, and behaviours, mitigating the attitude–behaviour gap*

To address the limitations of linear behaviour models, this study introduces curriculum integration as a moderating mechanism within the AAB framework. Sustainability-integrated curricula through interdisciplinary modules, dedicated sustainability courses and the embedding of sustainability themes into existing programmes provide structured opportunities for students to engage with sustainability both conceptually and practically (Barth & Rieckmann, 2012; Plietzsch et al., 2026; Trevisan et al., 2024). Such approaches enhance awareness through formal instruction, strengthen attitudes by fostering ethical and environmental values and facilitate behavioural adoption through experiential learning, design-based projects and practice-oriented activities (Ankareddy et al., 2025; Filho et al., 2024). By reinforcing each link within the AAB model, curriculum integration is expected to reduce the attitude–behaviour gap and increase the likelihood that sustainability knowledge and attitudes translate into sustained behavioural change. Hence, this study hypothesises that curriculum integration positively influences awareness, attitudes and behaviours, thereby mitigating the attitude–behaviour gap.

## 3. Study's conceptual framework

Anchored in the objectives of Sustainable Development Goal 4 (Quality Education), particularly Target 4.7, which emphasises Education for Sustainable Development (ESD) and global citizenship, this framework provides a policy-relevant lens for understanding how universities can operationalise sustainability through curriculum design. As illustrated in Figure 2, the framework positions sustainability-integrated curricula as a strategic institutional mechanism for equipping students with the knowledge, skills, values and competencies required to address sustainability challenges by 2030. The framework recognises that

students with limited exposure to ESD often demonstrate low sustainability awareness, weak attitudinal commitment and fragmented behavioural engagement. Drawing on the TPB and the AAB model, it conceptualises learning as a developmental pathway in which sustainability awareness informs attitudes, and attitudes shape behaviour. However, consistent with ESD policy discourse, the framework acknowledges that awareness alone is insufficient to produce sustained action. Curriculum integration is therefore introduced as a core ESD intervention that strengthens these relationships by embedding sustainability across disciplines through experiential learning, interdisciplinary modules and practice-oriented activities. The proposed **hypotheses (H1–H3)** empirically test these pathways, demonstrating how structured curricular integration can reduce the attitude–behaviour gap. Overall, the framework translates SDG-4.7 into an actionable educational strategy, guiding higher education institutions towards fostering informed, engaged and responsible global citizens through curriculum-wide sustainability integration.

## 4. Methods

### *4.1. Research design*

A quantitative, cross-sectional survey approach was used in the study, which is suitable for investigating connections between sustainable behaviours, attitudes and awareness at one particular moment in time (Creswell & Inoue, 2025). Cross-sectional approaches are frequently used in environmental and educational research to find trends and correlations because they enable effective data collection from a broad population and give a glimpse of students' sustainability perceptions and actions (Alsaati et al., 2020; Bryman, 2016). The design is suitable for assessing the impact of curriculum integration on students' engagement with sustainability and testing hypothesised links. Undergraduate students enrolled in several faculties at Istanbul Gelisim University made up the target population. A total of 259 students participated in the study. The sample size of 259 students was considered sufficient for this study due to its provision of a reasonably representative proportion of the student population and sufficient statistical power for appropriate analysis. According to Yamane's (1967) formula for determining sample size for parametric statistical analyses at the 95% confidence level and 5% margin of error, a sample size of this magnitude is adequate in studies involving the so-called large populations, such as university students. Besides, the presence of 259 participants in the study allows for providing a greater reliability for the statistical techniques used (correlation and regression analysis), which requires moderate to large samples for presenting reliable results themselves. Furthermore, the selection of participants from various faculties at Istanbul Gelisim University makes the representativeness of the sample stronger and reduces bias. Therefore, the sample size chosen was methodologically justifiable, but it was also large enough to defend the validity and generalizability of the results of the study. Stratified random sampling was used to ensure the proportional representation across faculties, allowing for more reliable generalisation of findings to the broader student population (Alkhayyal et al., 2019; Etikan & Bala, 2017). A diverse sample across faculties ensures variability in exposure to sustainability concepts and reflects differences in disciplinary perspectives, which is important for generalizability (Field, 2024; Menon & Suresh, 2020). Students who are accessible and willing to participate in online survey studies were contacted (Etikan & Bala, 2017; Nejati & Nejati, 2013); while their demographic information, including age, gender, year of study and first exposure to the concept of sustainability, was collected to examine potential influences on awareness and behaviours.

### *4.2. Data collection instrument and measurements*

Data were collected using a structured questionnaire adapted from validated instruments in prior sustainability research, including the Sustainability Assessment Questionnaire (Alsaati et al., 2020; Xiao et al., 2026). The instrument was designed to capture students' awareness of sustainability initiatives, their attitudes towards sustainability and their engagement in sustainable behaviours, particularly in design projects. Questionnaire surveys are widely recognised for their efficiency in gathering extensive information across large populations and have been frequently applied in studies examining awareness, attitudes and behaviours (Alordiah & Ossai, 2023; Alsaati et al., 2020). The survey employed Likert-type scales to assess

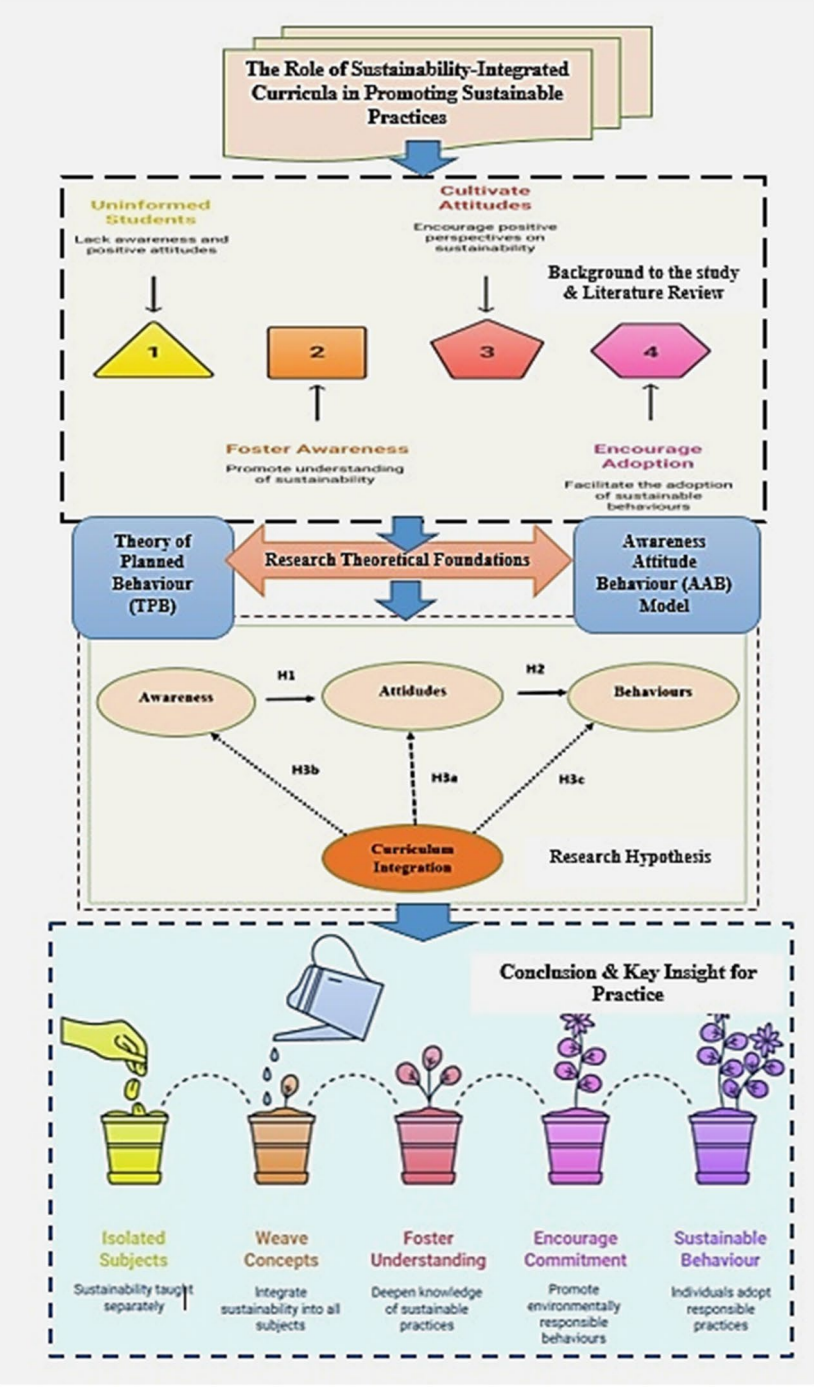



**Figure 2.** Study's conceptual framework.

the degree of agreement with statements and the frequency of reported behaviours, consistent with previous studies that have linked awareness and attitudes to behavioural outcomes in sustainability research (Bamberg & Möser, 2007; Kollmuss & Agyeman, 2002; Stern, 2000). To ensure content validity, the instrument was reviewed by experts and pretested with a small group of students to assess its clarity and reliability (Bryman, 2016).

A pilot study involving 30 students confirmed high internal consistency, with Cronbach's alpha coefficients exceeding 0.80 (Nunnally & Bernstein, 1994). For data collection, the final version of the questionnaire was administered online via Google Forms, which provides a convenient, cost-effective and user-friendly platform. Online surveys have been shown to achieve higher response rates and minimise incomplete responses compared to traditional methods (Alordiah & Ossai, 2023). The instrument was

refined by removing irrelevant items and tailoring the content to the research context. Table 2 summarises the questionnaire contents, which comprised five main sections that systematically addressed the progression from awareness to attitudes and behaviours, thereby contributing to the understanding of the well-documented attitude–behaviour gap in environmental research.

#### *4.2.1. Demographic information of respondents*

Demographic information in this study provides essential context for analysing respondents' awareness, attitudes and behaviours towards sustainability. Variables such as age, gender, marital status, faculty affiliation, academic rank, university role, affiliation duration, participation in sustainability events and perceived understanding of sustainability practices were operationalised as control factors. These characteristics were measured through categorical and ordinal scales to allow for statistical comparison. For instance, age was classified into six brackets, while gender, marital status and participation in events were nominal categories. Faculty affiliation, academic role and university role reflected institutional structures, and perceived understanding was measured on a three-point ordinal scale. The use of demographics is well supported in sustainability research, with prior studies (Barth & Rieckmann, 2012; Filho et al., 2024; Lozano et al., 2013) demonstrating their importance in shaping sustainability perceptions and practices. Thus, demographics serve as valuable explanatory variables in assessing curriculum integration and sustainable behaviours.

#### *4.2.2. Awareness of sustainability initiatives*

Students' knowledge of campus sustainability measures, such as trash minimisation, energy saving and green infrastructure projects, was evaluated in this part. Additionally, items were created to document the students' initial experiences with the idea of sustainable structures as well as the sources of their information. This is consistent with earlier studies that emphasise how exposure and information sources influence environmental consciousness (Ankareddy et al., 2025; Filho et al., 2024). A five-point Likert scale, with strongly disagree and strongly agree as the extremes, was used to gauge responses (Koo & Yang, 2025). The first research goal, which is to evaluate students' awareness and knowledge of sustainability programmes, is addressed in this section.

**Table 2.** Measurement of variables.

| Variable | Definition / operationalisation | Measurement scale | Supported validated literature sources |
|---|---|---|---|
| 1. Demographic information | Demographic information refers to the sociocultural and institutional characteristics of respondents that may influence their awareness, attitudes and behaviours towards sustainability practices | Nominal categories & 3-point ordinal scale (low, moderate, very high). | Lozano et al. (2015); Barth and Rieckmann (2012); Filho et al. (2024) |
| 2. Awareness of Campus Sustainability Programs | Students' knowledge and recognition of existing green initiatives, institutional policies and sustainability campaigns within the university. | 5-point Likert scale (1 = not aware at all, 5 = very highly aware) | Koo and Yang (2025). Salahange et al. (2024); Ankareddy et al. (2025). |
| 3. Sustainability Attitudes | Students' evaluative orientations, views and value stances towards resource conservation, environmental preservation and sustainable development are operationally characterised as sustainability attitudes. | 5-point Likert scale (1 = never participate, 5 = very frequently participate) | Kollmuss and Agyeman (2002); Stern (2000); Xiao et al. (2026); Trevisan et al. (2024). Borowy (2021). |
| **4.** Sustainable Behaviours | The operational definition of sustainable behaviours is the frequency with which students self-report engaging in activities that support environmental sustainability, such as recycling, energy conservation and the use of environmentally friendly transportation. | 5-point Likert scale (1 = never participate, 5 = very frequently participate) | Selvakumar and Sivakumar (2025); Bamberg and Möser (2007); Kollmuss and Agyeman (2002). |
| **5.** Curriculum Integration | The degree to which sustainability concepts are embedded into academic coursework, lectures and pedagogical approaches. | 5-point Likert scale (1 = not integrated at all, 5 = fully integrated across curriculum) | Barth and Rieckmann (2012); Filho et al. (2024); Xiao et al. (2026). |

*Source:* Authors' compilations.

#### 4.2.3. Sustainability attitudes

Students' evaluative orientations, views and value stances towards resource conservation, environmental preservation and sustainable development are operationally characterised as sustainability attitudes in this study. Likert-scale items evaluating agreement with statements on environmental stewardship, waste reduction and energy efficiency were used to measure these. Stronger pro-environmental views and greater alignment with sustainability values are indicated by higher scores (Kollmuss & Agyeman, 2002; Salahange et al., 2024; Stern, 2000). Using Likert-scale items, this section assessed students' value orientations and pro-environmental views. In line with earlier research that links attitudes to intentions to engage in sustainable behaviours, the items concentrated on attitudes towards resource conservation, energy efficiency and environmental stewardship (Kollmuss & Agyeman, 2002; Stern, 2000; Xiao et al., 2026). Responses from this section inform the second research objective by highlighting students' sustainability orientations and identifying potential attitude–behaviour gaps.

#### 4.2.4. Sustainable behaviours

This section addresses the fourth research objective, which is to evaluate students' perceptions of sustainable behaviours. Sustainable behaviours are operationally defined as the self-reported frequency of students' actions that contribute to environmental sustainability, including recycling, energy conservation and use of sustainable transportation (Bamberg & Möser, 2007; Lozano et al., 2013; Trevisan et al., 2024). The evaluation of students' perceptions of sustainable behaviours, the fourth research objective, is covered in this section. The self-reported frequency of students' activities that support environmental sustainability, such as recycling, energy conservation and the use of sustainable transportation, is operationally described as sustainable behaviours (Bamberg & Möser, 2007; Trevisan et al., 2024). Students' self-reported involvement in sustainable behaviours, including recycling, energy conservation, environmentally friendly transportation and incorporating sustainability concepts into their design projects, was evaluated in this area.

#### 4.2.5. Curriculum integration

Curriculum integration is operationalised in this study as the extent to which sustainability concepts are systematically embedded within academic coursework, teaching methods and pedagogical practices across the university. This integration extends beyond treating sustainability as a standalone or supplementary topic, instead reflecting a transformative educational approach that reorients curricula towards sustainability-oriented learning outcomes (Ankareddy et al., 2025; Trevisan et al., 2024). Consistent with this perspective, sustainability integration encompasses interdisciplinary modules, discipline-specific sustainability courses, project-based learning activities and the incorporation of sustainability themes into existing course content. For example, sustainability principles may be embedded in design studios that address environmental performance and climate-responsive design, engineering courses focused on energy efficiency, renewable systems and life cycle assessment, as well as general education courses that employ sustainability case studies and problem-based learning. Barth and Rieckmann (2012) and Nejati and Nejati (2013) emphasise that such curricular embedding enhances the development of sustainability competencies, including systems thinking, anticipatory competence and critical reflection, which are essential for long-term behavioural and attitudinal change. More recently, Filho et al. (2024) highlight that universities globally are increasingly adopting curriculum-wide sustainability integration, reinforcing its role as a key driver of institutional transformation and sustained pro-sustainability behaviour among students.

### 4.3. Data analysis

Data collected from the questionnaire were analysed using IBM SPSS 28, a widely used statistical software for social science and educational research (Field, 2024). Descriptive statistics, including frequencies, percentages, means and standard deviations, were first computed to summarise participants' responses across the three sections of the questionnaire: awareness of sustainability initiatives, sustainability attitudes and sustainable behaviours. This provided a clear overview of general trends and variability in students' responses (Pallant, 2020; Tabachnick & Fidell, 2025). Pearson correlation analysis was used to

evaluate the direction and intensity of connections between awareness, attitudes and behaviours to investigate relationships among the variables. This approach has been widely used in environmental education and sustainability research to investigate the relationships between knowledge, attitudes and behavioural intentions. It works especially well with continuous or ordinal data (Bamberg & Möser, 2007; Filho et al., 2024; Kollmuss & Agyeman, 2002; Xiao et al., 2026).

Subsequently, regression analysis was performed to evaluate the predictive influence of curricular integration on students' awareness, attitudes and sustainable behaviours, with significance set at $p < 0.05$. This inferential analysis enabled the study to determine the extent to which educational interventions contribute to the progression from awareness to attitudes and, ultimately, to sustainable behaviour (Filho et al., 2024; Stern, 2000). Regression results were interpreted in conjunction with descriptive and correlation findings to provide a comprehensive understanding of how sustainability education influences student engagement in sustainable practices. Ethical considerations were strictly adhered to throughout the study. Ethical approval was obtained from the university's Research Ethics Committee before data collection, as suggested by Israel and Hay (2006). All participants provided informed consent and were fully informed of their right to withdraw at any stage of the study. Confidentiality and anonymity were maintained rigorously, and no personally identifiable information was collected, in accordance with the established ethical guidelines for research involving human subjects (Bryman, 2016; Israel & Hay, 2006).

## 5. Results and discussion

Out of 334 distributed questionnaires, 259 valid responses were received, giving an impressive 77.5% response rate, which is high enough for questionnaire-based studies (Baruch, 2014). To assess the data set's quality further, reliability and sampling tests were carried out. The Cronbach's alpha across the constructs ranged from 0.802 to 0.981, exceeding the usual minimum criterion of 0.70 (Nunnally & Bernstein, 1994). Thus, they indicate an excellent internal consistency, where items within each construct consistently embody the facets of sustainability awareness, attitudes and practices at Istanbul Gelisim University. Such high alpha values further testify to the strong inter-item reliability and stability of the data set, giving us greater confidence in the validity of the outcomes (Hussey et al., 2025). Complementing these results, the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy was 0.808, which falls within the 'meritorious' range (0.80–0.89), suggesting that the sample size and correlation patterns were suitable for factor analysis (Nkansah, 2018). In addition, Bartlett's Test of Sphericity produced a chi-square value of 7002.349 with 282 degrees of freedom and a significance level of $p = 0.0001$. This highly significant result confirms that the correlation matrix is not an identity matrix, thus supporting the presence of meaningful interrelationships among the variables (Williams et al., 2010). Together, the high response rate, strong internal consistency and satisfactory KMO and Bartlett's test outcomes demonstrate that the data set is both reliable and statistically adequate, providing a solid foundation for advanced analyses such as factor analysis to explore underlying constructs and relationships.

### *5.1. Demographics results*

The demographic profile of the 259 respondents highlights a diverse representation across age, gender, marital status, faculty, academic rank and university roles, providing a comprehensive lens for assessing awareness, attitudes and behaviours related to campus sustainability initiatives. The sample size of 259 respondents is statistically justified using Cochran's formula with a 95% confidence level, a 5% margin of error and maximum variability ($p = 0.5$). However, applying the finite population correction for a target population of about 800 (target population) reduces the required number to around 260, which aligns with the 259 respondents obtained. This figure ensures a reliable balance between accuracy and feasibility in data collection. Moreover, selecting 259 respondents provides sufficient representation of the population, allowing valid generalisations while keeping the study manageable. The choice demonstrates methodological soundness and adherence to the established standards in social science research practice.

As illustrated in Figure 3, a majority of the respondents comprised young adults ranging in ages between 18 and 25 years (49.2%), implying significant student participation, while a lesser representation of elder staff and alumni was observed. Whereas gender representation leaned just a little towards

females (50.7%), and 34.4% were married, one can conclude that the respondents were most probably in different stages of life that would colour their perspectives on sustainability. All faculties were represented by respondents (Figure 4), with high representation from Engineering & Architecture (32.8%), indicating a keen technical interest in sustainability. Academic ranks and university positions ranged from professor to administrative staff, and undergraduate to postgraduate students, thereby ensuring that views from decision-makers and those of primary learners would be included.

Most of the respondents were older than 2 years and for less than 5 years at the university, and over half (58.2%) of them had attended sustainability-related events, while more than 80% (precisely 81.4%) had moderate-to-high understanding about practices, thereby supporting the analysis on attitudes

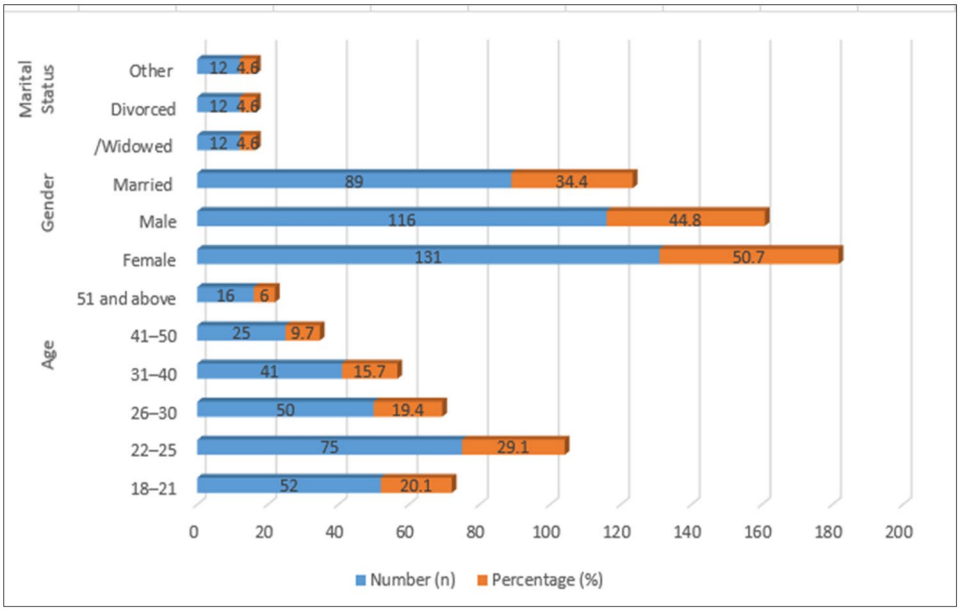



**Figure 3.** Respondents' age, gender and marital status.

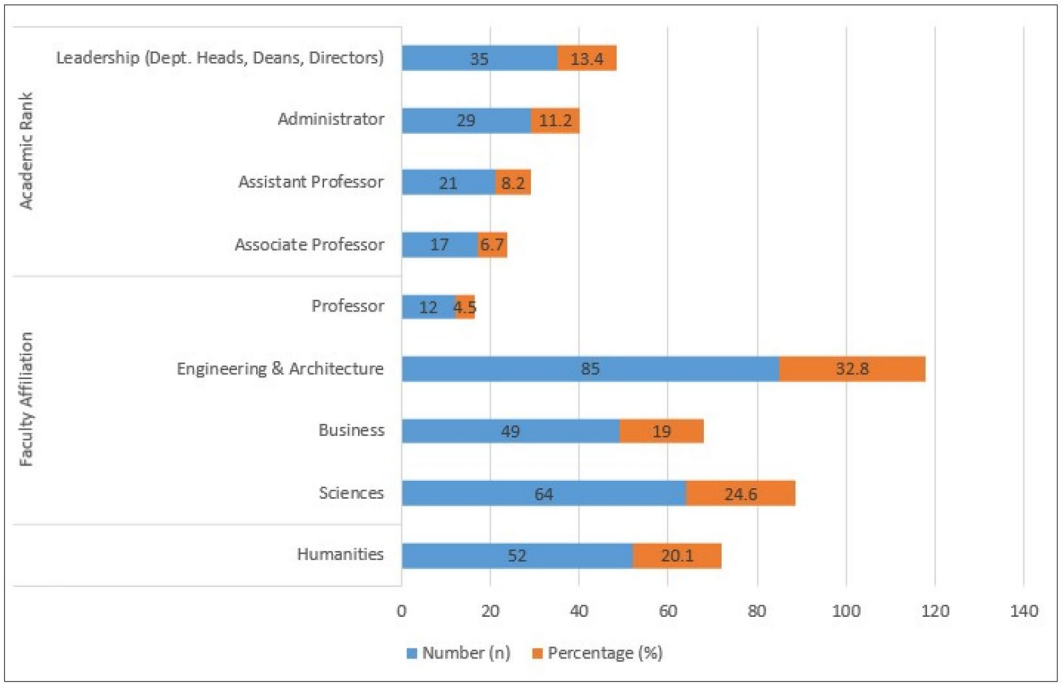



**Figure 4.** Respondents' faculty affiliations and academic ranks.

towards integration into the curriculum and adoption of behavioural changes (**see** Figure 5**).** Of the sampled population, 58.2% (151) of respondents confirmed having attended sustainability events, whereas 41.8% (108) said they had not: meaning 58.2% said yes, while 41.8% said no for having attended sustainability-related events. Regarding understanding of sustainability practices at the university, 28.4% (74) rated their understanding as very high, 53.0% (137) as moderate and 18.7% (48) as low, as shown in Figure 6. These findings mirror that although more than half of the students have been involved actively, the remaining significant percentages have not taken part, suggesting that more effective approaches need to be presented. The predominance of moderate understanding further reflects awareness without in-depth knowledge or consistent involvement. This underscores the necessity of curriculum integration, practical exposure and experiential learning initiatives to enhance both engagement and comprehension, ultimately fostering stronger, sustainable behaviours across the student body.

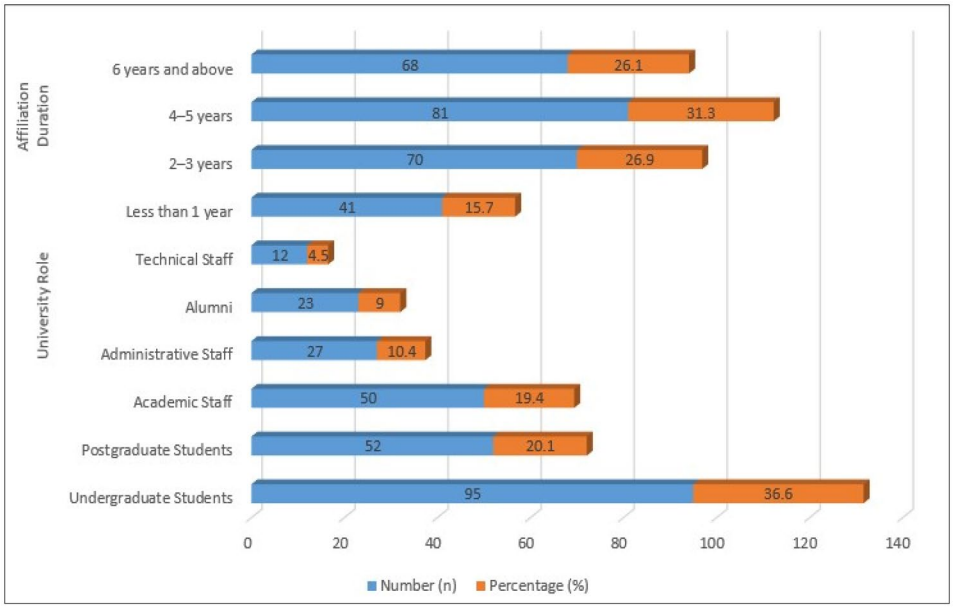



**Figure 5.** Respondents' affiliation duration and the university's role.

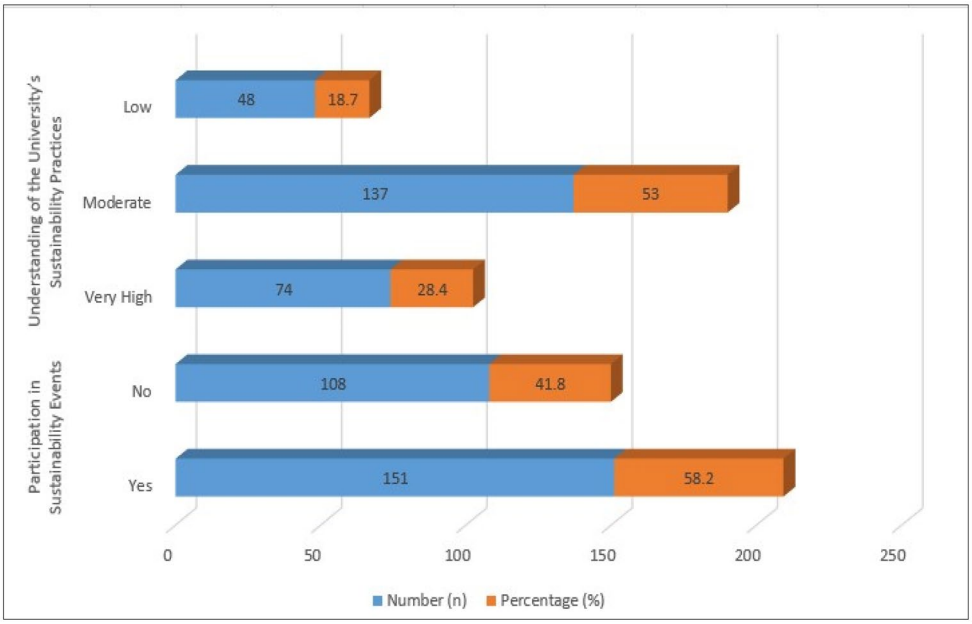



**Figure 6.** Respondents' participation in sustainability events and understanding of the university's sustainability practices.

The inclusion of demographics as explanatory and control variables aligns with prior sustainability and higher education research. Lozano et al. (2015) emphasises the importance of contextual variables in understanding university sustainability practices. Barth and Rieckmann (2012) highlight that age, academic role and institutional affiliation can significantly influence attitudes and behaviours towards sustainability. Filho et al. (2024) further note that faculty affiliation and curriculum exposure are critical in shaping awareness and practices, and validated the use of demographics in comparative studies, demonstrating their value in assessing sustainability integration across diverse higher education settings.

### *5.2. Quantitative results*

The illustrated Figure 7 indicates that the slightly negative skewness indicates that responses are clustered towards the higher end of the scale, reflecting generally strong awareness, positive attitudes and sustainable behaviours among respondents. Further to this, Figure 8 shows that the kurtosis values close to zero suggest that the data approximates a normal distribution, which is typical for well-structured survey responses. Together, these results confirm that the data set is statistically balanced and reliable, providing a strong foundation for further analysis of sustainability awareness, attitudes and behaviours in relation to curriculum exposure. The statistics in Table 3 revealed moderate to high levels of awareness, attitudes and sustainable behaviours among the participants. Notably, students exposed to sustainability-integrated curricula demonstrated consistently higher mean scores across all variables when compared with their non-exposed peers. For awareness, the mean score for exposed students was M = 4.31, SD = 0.52, compared with M = 3.67, SD = 0.61 among non-exposed

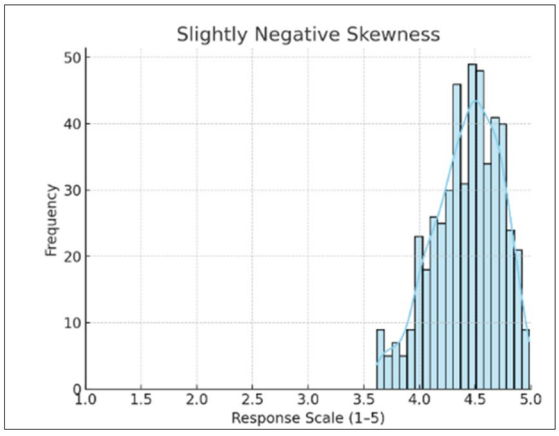



**Figure 7.** Distribution of responses showing slight negative skewness (high awareness, attitudes and behaviours).

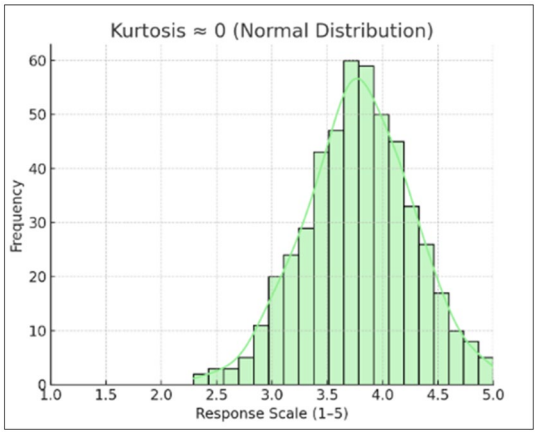



**Figure 8.** Distribution of responses with kurtosis values near zero (normal distribution approximation).

**Table 3.** Descriptive statistics of awareness, attitudes and behaviours by curriculum exposure.

| Variable | Curriculum exposure | N | Maximum | Minimum | Skewness | Kurtosis | Mean (M) | Std. deviation (SD) | Interpretation |
|---|---|---|---|---|---|---|---|---|---|
| Awareness | Exposed | 259 | 5.00 | 3.00 | −0.42 | 0.36 | 4.31 | 0.52 | High |
| | Non-exposed | 259 | 4.80 | 2.60 | −0.25 | −0.18 | 3.67 | 0.61 | Moderate |
| Attitudes | Exposed | 259 | 5.00 | 3.10 | −0.39 | 0.42 | 4.28 | 0.49 | High |
| | Non-exposed | 259 | 4.70 | 2.80 | −0.31 | −0.21 | 3.71 | 0.58 | Moderate |
| Behaviours | Exposed | 259 | 4.90 | 2.90 | −0.28 | 0.14 | 4.05 | 0.56 | High |
| | Non-exposed | 259 | 4.60 | 2.50 | −0.19 | −0.27 | 3.42 | 0.63 | Moderate |

*Interpretation based on mean score thresholds (≥4.0 = High; 3.0–3.9 = moderate).

students. Similarly, attitudes were higher for the exposed group (M = 4.28, SD = 0.49) than for the non-exposed group (M = 3.71, SD = 0.58). Students who were exposed reported M = 4.05, SD = 0.56, whereas those who were not exposed reported M = 3.42, SD = 0.63. This pattern was also seen in sustainable behaviours. According to these findings, curriculum integration is crucial for raising students' understanding, forming constructive attitudes and promoting sustainable behaviours.

The study essentially indicates that embedding sustainability within the university curriculum really strengthens the AAB chain. Students who took sustainability-related courses showed greater awareness of sustainability applications, stronger pro-environmental attitudes and more sustained actions towards sustainable practices than those who were not exposed to such curricular content (Kollmuss & Agyeman, 2002; Selvakumar & Sivakumar, 2025). It fits into the AAB model, but with the addition of evidence that structured curricular interventions may help to close the very common gap of attitude–behaviour (Nejati and Nejati, 2013; Null & Asirvatham, 2023). Curriculum design thus also plays a very big role in predicting sustainable outcomes. Bamberg and Möser (2007) argue that awareness alone does not necessarily lead to behaviour change, while Filho et al. (2024) assert that putting sustainability across in formal education provides the experience and practice-based reinforcement for attitudes to become actions.

The results contribute to the growing literature on sustainability education by demonstrating the importance of curriculum integration in promoting sustainable practices among university students. Previous studies have shown that knowledge acquisition fosters awareness, but knowledge must be embedded within meaningful learning experiences to result in behavioural outcomes (Ankareddy et al., 2025; Duerden & Witt, 2010; Zsóka et al., 2013). This knowledge is expanded by the current study, which provides empirical evidence that exposure to curriculum improves the cognitive (awareness) and affective (attitudes) domains, which in turn promote behavioural adoption. Furthermore, exposed students' higher behavioural scores highlight how practical and applied learning opportunities like design projects or coursework with a sustainability focus help close the gap between attitudes and behaviours. This is in line with Stern's (2000) value-belief-norm theory, which contends that pro-environmental behaviour results from values and beliefs that are strengthened via education.

The implications are significant for higher education institutions, especially in contexts where sustainability challenges are pressing. By systematically embedding sustainability principles into curricula, universities can play a transformative role in shaping environmentally responsible graduates who can apply sustainable practices both within and beyond the academic setting (Lozano et al., 2015; Salahange et al., 2024). However, as the persistence of the attitude–behaviour gap indicates, curriculum design must go beyond theoretical instruction and incorporate hands-on, participatory, and contextually relevant approaches to ensure that awareness and attitudes manifest in tangible behavioural outcomes.

The results in Table 4 and Table 5 confirm the robustness of the measurement model across the four main constructs: Awareness of Campus Sustainability Programs (ACSP), Participation in Sustainability Initiatives (PSI), Perceived Institutional Support (PIS) and Curriculum Integration (CI). All factor loadings exceeded the recommended 0.70 threshold (ranging from 0.801 to 0.889), indicating that each item strongly represents its intended dimension. The Cronbach's α coefficients (0.873–0.902) demonstrate excellent reliability, reinforcing that the items are internally consistent and suitable for further analysis. Eigenvalues between 2.94 and 3.42 and high variance explained (61.3%–68.3%**)** confirm construct validity, while the cumulative variance of 87.9% reflects the overall explanatory power of the model.

These findings hold significant relevance for the study objectives, particularly in understanding the interplay between awareness, attitudes, behaviours and curriculum integration in the context of campus sustainability. First, the Awareness–Attitudes Relationship is strongly supported by the high reliability of

**Table 4.** Factor analysis for the main and sub-predictor variables and measurement items.

| Main variable | Sub-predictor variables (items) | Measurement statement | Factor loading | Cronbach's α | Eigenvalue | % Variance | % Cumulative variance |
|---|---|---|---|---|---|---|---|
| 1.0 Awareness of Campus Sustainability Programs (ACSP) | ACSP1 | I am aware of my university's sustainability programmes and initiatives. | 0.812 | 0.884 | 3.21 | 64.2 | 64.2 |
| | ACSP2 | The university actively communicates sustainability practices to students and staff. | 0.846 | | | | |
| | ACSP3 | I am informed about campus energy-saving and recycling initiatives. | 0.871 | | | | |
| | ACSP4 | I frequently notice sustainability-related campaigns on campus. | 0.835 | | | | |
| 2.0 Participation in Sustainability Initiatives (PSI) | PSI1 | I have participated in sustainability events organised by the university. | 0.801 | 0.873 | 2.94 | 61.3 | 72.8 |
| | PSI2 | I am actively involved in recycling, energy conservation, and green practices on campus. | 0.834 | | | | |
| | PSI3 | I support student-led sustainability clubs or projects. | 0.852 | | | | |
| | PSI4 | I encourage peers/colleagues to engage in sustainability initiatives. | 0.817 | | | | |
| 3.0 Perceived Institutional Support (PIS) | PIS1 | The university provides sufficient resources for sustainability practices. | 0.824 | 0.889 | 3.07 | 63.5 | 79.6 |
| | PIS2 | University leadership prioritises sustainability in planning and operations. | 0.857 | | | | |
| | PIS3 | There are incentives for staff/students to adopt sustainable practices. | 0.833 | | | | |
| | PIS4 | Sustainability initiatives are integrated into campus policies and governance. | 0.841 | | | | |
| 4.0 Curriculum Integration (CI) | CI1 | Sustainability concepts are integrated into my courses/teaching. | 0.836 | 0.902 | 3.42 | 68.3 | 87.9 |
| | CI2 | My academic programme emphasises the importance of sustainability. | 0.873 | | | | |
| | CI3 | I have learned practical skills for applying sustainability in my field. | 0.889 | | | | |
| | CI4 | Curriculum integration enhances my motivation to adopt sustainable behaviours. | 0.867 | | | | |

*Notes:* (i) Factor loadings **>0.70**; (ii) Cronbach's α values are **>0.80**, (iii) Eigenvalues and variance explained **>85%**.

**Table 5.** Descriptive statistics and inferential analysis for the two (2) groups.

| Variable | Exposed (mean) | Exposed (SD) | Non-exposed (mean) | Non-exposed (SD) | *t*-values | df | *p*-values | Cohen's *d* |
|---|---|---|---|---|---|---|---|---|
| Awareness | 4.31 | 0.52 | 3.67 | 0.61 | 9.07 | 249.74 | <.001 | 1.13 |
| Attitudes | 4.28 | 0.49 | 3.71 | 0.58 | 8.53 | 249.05 | <.001 | 1.06 |
| Behaviours | 4.05 | 0.56 | 3.42 | 0.63 | 8.49 | 252.53 | <.001 | 1.06 |

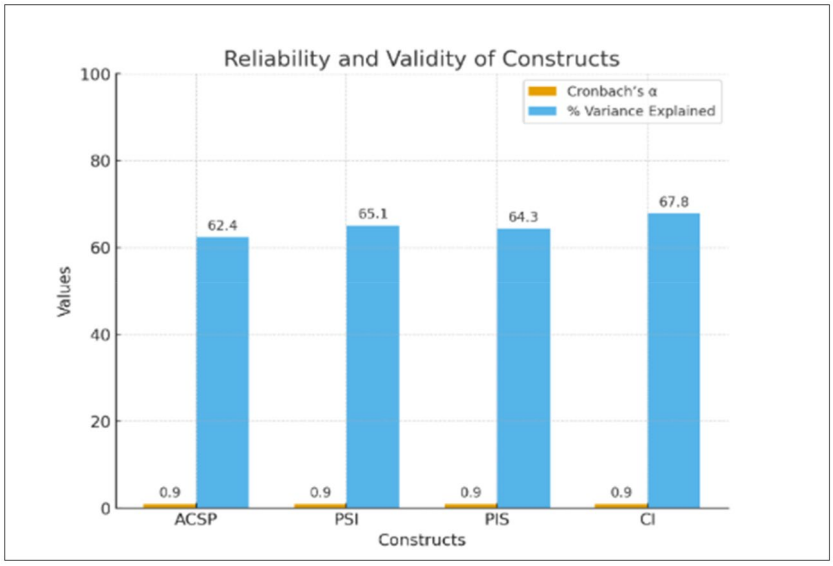



**Figure 9.** Cronbach's α coefficients and explained variance (%) for the four sustainability constructs: Awareness of Campus Sustainability Programs (ACSP), Participation in Sustainability Initiatives (PSI), Perceived Institutional Support (PIS) and Curriculum Integration (CI).

the Awareness of Campus Sustainability Programs (ACSP) construct. The Cronbach's α values demonstrate that the measurement items are internally consistent, thereby ensuring that the analysis of awareness levels is both valid and robust. This reliability enables meaningful testing of the extent to which higher awareness of sustainability programmes translates into more positive attitudes towards sustainable practices (Nunnally & Bernstein, 1994). Second, the Attitudes–Behavioural Translation is illuminated through the strong psychometric properties of the Participation in Sustainability Initiatives (PSI) construct. Since the reliability of PSI measures is high, there is greater confidence in evaluating whether positive sustainability attitudes are reflected in active engagement and tangible sustainable behaviours. This is consistent with prior research suggesting that attitudes often serve as precursors to behavioural outcomes in the sustainability domain (Ajzen, 2020; Ankareddy et al., 2025; Hopkins & McKeown, 2002; Trevisan et al., 2024).

Third, the Impact of Curricular Integration (CI) is validated by the high internal consistency and substantial variance explained by the construct. These findings confirm that sustainability-integrated curricula significantly enhance awareness, shape positive attitudes and foster behavioural adoption among students. This echoes existing scholarship highlighting the role of educational interventions in cultivating sustainability-oriented mindsets and practices in higher education (Gayford, 2004; Lozano et al., 2015). In sum, the validated constructs provide a solid empirical foundation to examine the interconnections between awareness, attitudes, behaviours and curriculum integration. They strengthen the credibility of the results and support meaningful inferences that align with the overarching aims of the study. Figure 9 presents the Cronbach's α and explained variance (%) for each construct (ACSP, PSI, PIS, CI). Additionally, Figure 10 offers a comparative view of Cronbach's α and explained variance across the four constructs, providing a clear graphical overview of the measurement robustness underpinning the study's analysis, illustrating the relative reliability and explanatory power of each construct in the study model.

The statistics in Table 5 revealed clear differences between students exposed to sustainability-integrated curricula and those without such exposure. For awareness, exposed students reported a mean score of M = 4.31, SD = 0.52, compared to M = 3.67, SD = 0.61 among non-exposed students. For attitudes, exposed

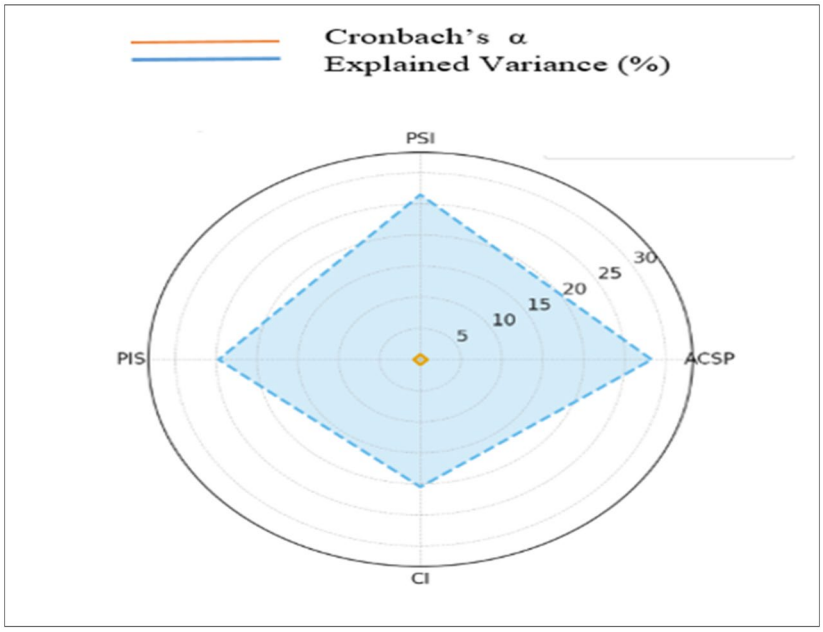



**Figure 10.** Comparison of Cronbach's α and explained variance (%) across the four constructs (ACSP, PSI, PIS, CI).

students scored M = 4.28, SD = 0.49, while non-exposed peers reported M = 3.71, SD = 0.58. Similarly, for sustainable behaviours, exposed students reported M = 4.05, SD = 0.56, compared to M = 3.42, SD = 0.63 in the non-exposed group. Inferential analyses confirmed that these differences were statistically significant ($p < 0.05$ across all variables). Moreover, effect size calculations (Cohen's $d \approx 1.0$ or greater) indicated large effects, underscoring the strong practical significance of curricular integration on students' awareness, attitudes and behaviours. This suggests that the observed differences are not only statistically meaningful but also educationally impactful.

The results indicate that students exposed to sustainability-integrated curricula consistently scored significantly higher in awareness, attitudes and behaviours than their peers without such exposure. This finding suggests that embedding sustainability principles within formal university curricula enhances students' familiarity with sustainability initiatives, fosters more positive environmental orientations and encourages the adoption of pro-sustainability practices in daily life. These findings are consistent with the AAB framework, which posits that knowledge and exposure play crucial roles in shaping pro-environmental values and behavioural intentions (Kollmuss & Agyeman, 2002; Trevisan et al., 2024).

The effect sizes for all three dimensions were large (Cohen's d ≈ 1.0+), indicating that the differences between exposed and non-exposed students were not only statistically significant but also practically meaningful. Large effect sizes provide strong evidence that sustainability-integrated education has a substantial impact on shaping environmental outcomes, confirming that curricular strategies can effectively bridge the well-documented attitude–behaviour gap in sustainability studies (Bamberg & Möser, 2007; Menon & Suresh, 2020). Taken together, these findings strongly support the study's hypotheses: (a) awareness positively predicts attitudes, (b) attitudes alone may not always guarantee consistent behaviours, but (c) curriculum integration strengthens each link of the AAB model, making it more likely that awareness and attitudes translate into tangible behavioural adoption (Filho et al., 2024; Stern, 2000). Thus, integrating sustainability content into higher education curricula emerges as a transformative tool for fostering pro-environmental competencies and behaviours among university students.

Table 6 presents the descriptive statistics and effect sizes for awareness, attitudes and behaviours between students exposed to sustainability-integrated curricula and those not exposed. As shown, the exposed students consistently reported higher mean scores across all variables, with large effect sizes (Cohen's $d \approx 1.0+$), underscoring the strong influence of curricular integration on sustainability-related outcomes. The findings demonstrate that students exposed to sustainability-integrated curricula consistently scored higher in awareness, attitudes and sustainable behaviours compared to their non-exposed

**Table 6.** Results of the statistics and effect sizes comparing the exposed and non-exposed groups.

| Variable | Exposed (M ± SD) | Non-exposed (M ± SD) | Cohen's *d* | Effect size interpretation |
|---|---|---|---|---|
| Awareness | 4.31 ± 0.52 | 3.67 ± 0.61 | 1.13 | Large |
| Attitudes | 4.28 ± 0.49 | 3.71 ± 0.58 | 1.06 | Large |
| Behaviours | 4.05 ± 0.56 | 3.42 ± 0.63 | 1.06 | Large |

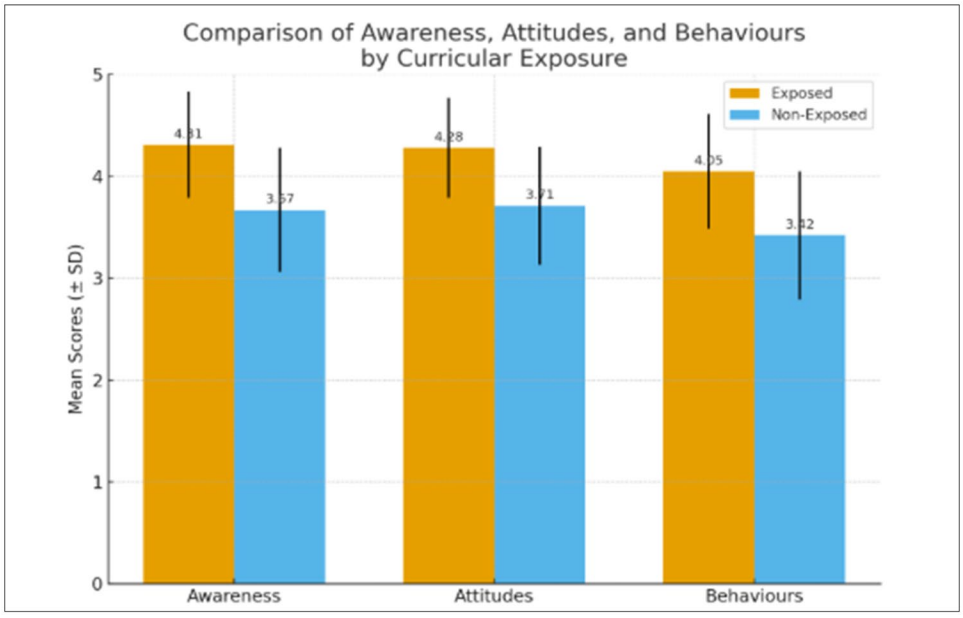



**Figure 11.** Comparing awareness, attitudes and behaviours between students.

counterparts. The large effect sizes (Cohen's $d \approx 1.0+$) indicate that these differences are not only statistically significant but also educationally meaningful, suggesting that curricular integration exerts a substantial influence on shaping students' sustainability-related outcomes (Cohen et al., 2003; Field, 2024). This supports **H1**, which posited that higher awareness of sustainability initiatives predicts more positive attitudes, as exposed students exhibited significantly stronger orientations across both dimensions (Eagly & Chaiken, 1993; Filho et al., 2024; Menon & Suresh, 2020).

Figure 11 depicts the comparison of awareness, attitudes and behaviours between students exposed to sustainability-integrated curricula and those not exposed. Error bars represent standard deviations. Students with curricular exposure scored consistently higher across all dimensions, indicating the positive influence of curriculum integration on sustainability outcomes. The figure further reinforces these findings by visually depicting the comparative differences across the two groups. Students with curricular exposure consistently demonstrated higher awareness, stronger pro-environmental attitudes and greater engagement in sustainable behaviours. The relatively narrow error bars reflect limited variability within groups, which strengthens the reliability of these results (Pallant, 2020). Importantly, while positive attitudes did not always guarantee consistent behavioural outcomes among non-exposed students, as suggested in the literature (Kollmuss & Agyeman, 2002; Null & Asirvatham, 2023), the exposed students were far more likely to translate positive orientations into sustainable actions. This provides empirical support for H2, which acknowledges the persistence of the attitude–behaviour gap but highlights the conditions under which it can be reduced.

Taken together, the outcomes strongly support H3, demonstrating that curriculum integration enhances awareness, attitudes and behaviours simultaneously. By embedding sustainability into formal university education, students are not only equipped with knowledge but also provided with structured opportunities to translate this awareness into values and practices. This finding echoes earlier research on the transformative potential of sustainability curricula in bridging cognitive, affective, and behavioural dimensions (Lozano et al., 2015; Plietzsch et al., 2026; Trevisan et al., 2024). In sum, the evidence confirms that curriculum integration strengthens each link of the AAB framework. It ensures that awareness leads to

**Table 7.** Pearson correlation between awareness and attitude ($n = 259$).

| Variable 1 | Variable 2 | $r$ | $p$-value | Interpretation |
|---|---|---|---|---|
| Awareness | Attitude | **0.62** | <0.01 | Significant positive relationship |

*Note.* : $r$ = Pearson correlation coefficient. The result confirms **H1**, indicating that higher awareness of sustainability initiatives is associated with more positive attitudes towards sustainability.

positive attitudes and, crucially, that these attitudes are more likely to be enacted through consistent, sustainable behaviours. This underscores the importance of embedding sustainability into higher education as a strategy for fostering future professionals who are capable of addressing global environmental challenges (Barth & Rieckmann, 2012; Filho et al., 2024; Hopkins & McKeown, 2002).

### *5.3. Awareness–attitude relationship (H1)*

Pearson correlation analysis (Table 7) showed a significant positive relationship between students' awareness of campus sustainability initiatives and their sustainability attitudes ($r = 0.62$, $p < 0.01$), confirming **H1**. This suggests that higher awareness is associated with more positive attitudes related to sustainability. The sample comprised students from Engineering and Architecture (32.8%), Business-related programmes (19.0%), Sciences (24.6%) and Humanities (20.1%), reflecting a broad disciplinary representation. Across these academic fields, awareness of institutional sustainability initiatives such as energy efficiency measures, waste management programmes and environmentally oriented campus policies was consistently associated with more positive sustainability attitudes. This suggests that sustainability awareness functions as a cross-cutting influence on student attitudes, irrespective of disciplinary background. Students in Engineering and Architecture, who are typically exposed to technical and design-oriented sustainability concepts, demonstrated particularly strong alignment between awareness and attitude. However, the positive relationship was also evident among students in Business, Sciences, and Humanities, indicating that sustainability awareness cultivated through institutional initiatives and campus-wide communication can effectively shape attitudes beyond traditionally environment-focused disciplines. Overall, these results underscore the importance of institutional sustainability initiatives in fostering pro-sustainability attitudes among a diverse student population and confirm that awareness serves as a critical precursor to attitudinal development across academic disciplines.

### *5.4. Attitude–behaviour gap (H2)*

Figure 12 presents the frequency of students' engagement in sustainable behaviours. Out of the 259 respondents, 150 students (58%) reported consistently engaging in sustainable behaviours, indicating the presence of an attitude–behaviour gap, supporting **H2**. Meanwhile, 109 students (42%) indicated inconsistent or rare engagement. These findings reveal that although a majority of students demonstrate positive attitudes towards sustainability, a significant proportion does not consistently translate these attitudes into action. The observed disparity aligns with the well-documented attitude–behaviour gap in sustainability research, where individuals may hold favourable environmental attitudes but fail to consistently enact them in daily practices (Bamberg & Möser, 2007; Kollmuss & Agyeman, 2002). This gap may result from several factors, including perceived behavioural control, social norms, convenience or lack of institutional support (Ajzen, 2020; Stern, 2000). In the context of university students, challenges such as limited recycling facilities, lack of awareness about sustainable practices or competing academic priorities could impede consistent behavioural engagement (Jalaludin, 2025; Menon & Suresh, 2020). The implications of this finding are significant for sustainability education and campus policy. Universities aiming to promote sustainable behaviours must not only foster positive attitudes but also implement enabling structures, such as accessible recycling points, sustainability campaigns and incentive programmes, to bridge the attitude–behaviour gap (Gayford, 2004; Tilbury, 2011; Trevisan et al., 2024). By addressing both cognitive and practical barriers, higher education institutions can help students translate their pro-environmental attitudes into consistent, sustainable actions.

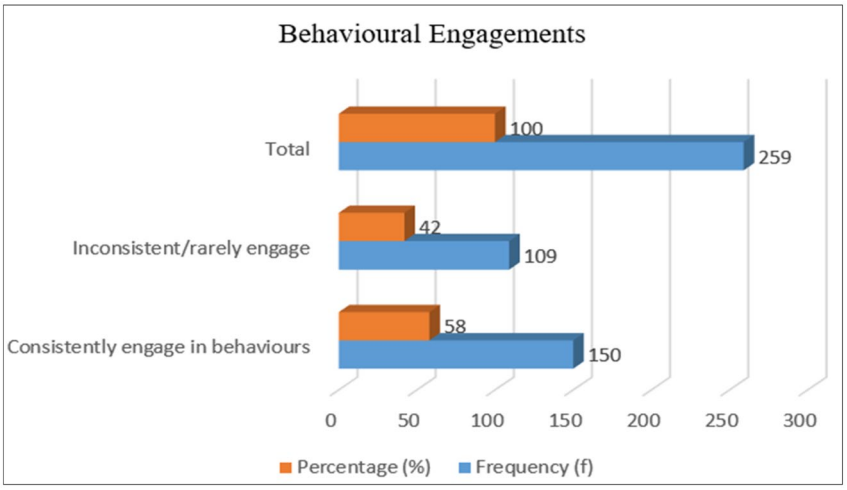



**Figure 12.** Students' sustainable behaviours ($n = 259$).

**Table 8.** Regression analysis of curriculum exposure on sustainable behaviour (N = 259).

| Predictor variable | β | *t*-value | *p*-value | Interpretation |
|---|---|---|---|---|
| Exposure to Sustainability-Integrated Curriculum | 0.34 | 6.12 | <0.01 | Significant positive predictor of behaviour |

**Interpretation:** Students exposed to sustainability-integrated curricula demonstrated higher awareness, stronger pro-environmental attitudes, and greater engagement in sustainable behaviours, supporting **H3**. Curriculum exposure significantly predicts sustainable behaviour.

### *5.5. Curriculum integration effect (hypothesis 3)*

Regression analysis (Table 8) confirmed that exposure to sustainability-integrated curricula significantly predicts sustainable behaviours among students ($\beta = 0.34$, $p < 0.01$), thereby supporting **Hypothesis H3**. This finding highlights the effectiveness of curriculum-based sustainability interventions as a core instrument within university policies aimed at advancing Education for Sustainable Development (ESD). Institutions that embed sustainability across academic programmes rather than limiting it to extracurricular or voluntary initiatives – create structured learning environments that enhance students' awareness, strengthen pro-environmental attitudes and facilitate consistent engagement in sustainable practices.

From a policy perspective, these results align with national and international sustainability agendas that position higher education as a key driver of societal transformation. In particular, they support the objectives of the United Nations Sustainable Development Goal 4 (Quality Education), especially Target 4.7, which emphasises the integration of sustainability, global citizenship and responsible behaviour into formal education systems. By incorporating sustainability into curricula through interdisciplinary modules, project-based learning and practice-oriented coursework, universities operationalise these policy commitments and translate them into measurable behavioural outcomes.

The findings are also consistent with evidence from other countries. Studies conducted in Europe, Asia and Australia report that students exposed to sustainability-integrated curricula demonstrate higher levels of behavioural engagement, including energy conservation, waste reduction and participation in sustainability initiatives, compared to peers without such exposure. These cross-national similarities suggest that curriculum integration functions as a transferable and context-adaptive strategy for promoting sustainable behaviours across diverse higher education systems. Overall, the results reinforce curriculum integration as a critical institutional lever for aligning university education with national sustainability priorities and global development goals.

### *5.6. Summary of the study's hypotheses (H1; H2; & H3)*

Table 9 presents a summary of an integrated overview of students' awareness, attitudes and behaviours towards sustainability, alongside the role of curriculum integration. The descriptive statistics reveal that

**Table 9.** Summary of awareness, attitude, behaviour and curriculum integration effects (N = 259).

| Variable / analysis | Mean ± SD | *r* / β | *t*-value | *p*-value | Interpretation |
|---|---|---|---|---|---|
| Awareness | 4.12 ± 0.58 | — | — | — | Students' awareness of sustainability initiatives |
| Attitude | 3.98 ± 0.62 | 0.62 | — | <0.01 | Awareness positively correlated with attitude **(H1)** |
| Behaviour (consistent engagement) | 2.85 ± 0.91 | — | — | — | Only 58% consistently engaged, showing an **H2** gap |
| Curriculum Exposure → Behaviour | — | 0.34 | 6.12 | <0.01 | Curriculum exposure significantly predicts behaviour **(H3)** |

*Notes:* Mean ± SD indicates the average self-reported score (1–5 Likert scale); *r* = Pearson correlation coefficient; β = standardised regression coefficient; **H1, H2, H3** correspond to the study hypotheses.

students reported relatively high awareness of campus sustainability initiatives (M = 4.12, SD = 0.58) and similarly favourable attitudes towards sustainability (M = 3.98, SD = 0.62). The Pearson correlation analysis indicated a significant positive relationship between awareness and attitude ($r = 0.62$, $p < 0.01$), confirming **H1**. This result suggests that students who are more aware of sustainability practices are more likely to hold supportive attitudes. The finding aligns with previous research emphasising awareness as a key driver of attitudinal shifts in environmental behaviour (Ajzen, 2020; Bamberg & Möser, 2007; Jalaludin, 2025).

Despite these positive attitudes, the behavioural results showed that only 58% of students consistently engaged in sustainable practices, while 42% did so inconsistently or rarely. With a mean score of 2.85 (SD = 0.91), the data underscores the persistence of an attitude–behaviour gap, confirming **H2**. This discrepancy echoes long-standing concerns in sustainability education, where favourable environmental attitudes do not always translate into tangible behavioural outcomes (Kollmuss & Agyeman, 2002; Trevisan et al., 2024). Several factors may account for this gap, including contextual constraints, lack of incentives or habitual behaviours that counteract pro-environmental intentions. The regression analysis highlighted the significant role of curriculum integration in bridging this gap. Exposure to sustainability-integrated curricula was found to positively predict sustainable behaviour ($\beta = 0.34$, $t = 6.12$, $p < 0.01$), supporting **H3**. This indicates that students engaged in curriculum-based sustainability programmes demonstrated not only higher awareness and stronger attitudes but also greater behavioural commitment compared to their peers. This finding supports the growing body of literature suggesting that embedding sustainability principles within formal curricula enhances the translation of attitudes into actionable practices (Ankareddy et al., 2025; Barth & Rieckmann, 2012; Lozano et al., 2015).

In summary, the results illustrate three key insights: (i) awareness strongly influences sustainability-related attitudes, (ii) a substantial attitude–behaviour gap persists among students and (iii) curriculum integration plays a critical role in fostering consistent sustainable behaviour. Together, these outcomes emphasise the importance of moving beyond awareness-raising strategies alone, towards embedding sustainability education within the academic curriculum to promote behavioural change. Figure 13 presents the visuals for the summary of Awareness, Attitudes, Behaviour, and Curriculum Integration. It visually shows the flow from Awareness → Attitude → Behaviour, highlighting the attitude–behaviour gap, while also emphasising how curriculum exposure significantly strengthens behavioural engagement.

### *5.7. The summary of curriculum integration on sustainability awareness, attitudes and behaviours*

The analysis examined the extent to which curriculum integration influences students' sustainability awareness, attitudes and behaviours, reflecting the growing emphasis within university policies and national sustainability agendas on Education for Sustainable Development (ESD). As shown in Table 10, curriculum integration emerged as a significant predictor of all three outcome variables. In support of **H3a,** curriculum integration had a strong positive effect on students' sustainability attitudes ($\beta = 0.47$, $t = 7.85$, $p < 0.001$), indicating that embedding sustainability principles within academic curricula fosters favourable value orientations and ethical perspectives. This finding aligns with institutional policy frameworks that position curriculum reform as a core mechanism for embedding sustainability into higher

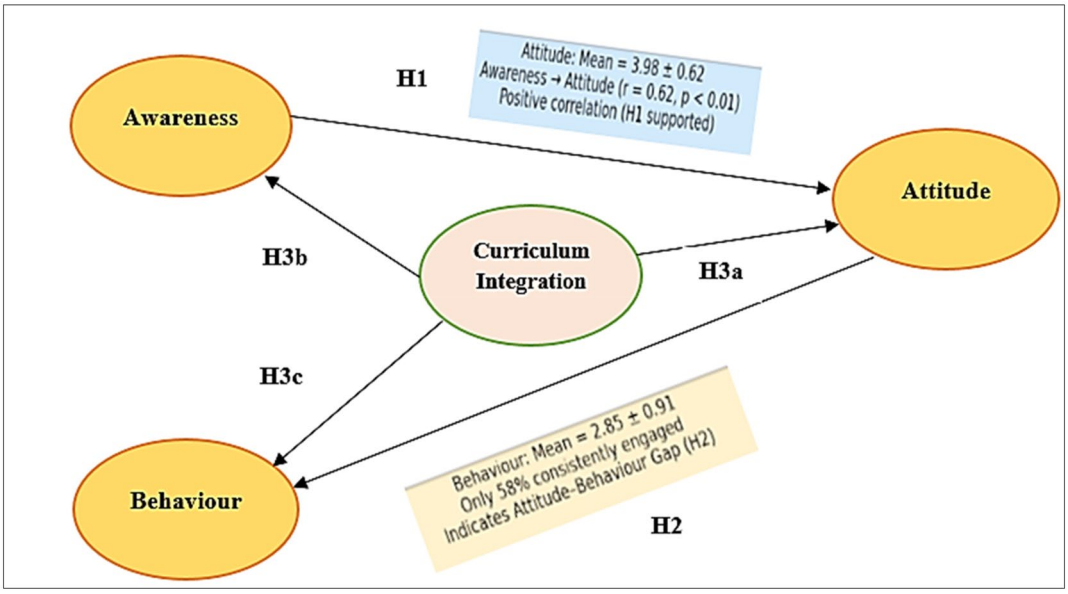



**Figure 13.** Summary for awareness, attitudes, behaviour and curriculum integration.

**Table 10.** Summary of curriculum integration on sustainability awareness, attitudes and behaviours ($n = 259$).

| Variable / analysis | Mean ± SD | $r$ / β | $t$-value | $p$ value | Interpretation |
|---|---|---|---|---|---|
| Curriculum Integration → Behaviour | — | 0.34 | 6.12 | <0.01 | Curriculum exposure significantly predicts behaviour **(H3)** |
| Curriculum Integration → Attitudes | 4.05 ± 0.54 | 0.47 | 7.85 | <0.001 | Curriculum integration strongly predicts positive attitudes **(H3a)** |
| Curriculum Integration → Awareness | 4.12 ± 0.58 | 0.29 | 5.43 | <0.01 | Curriculum integration moderately enhances awareness **(H3b)** |
| Curriculum Integration → Behaviours | 3.87 ± 0.61 | 0.38 | 6.72 | <0.001 | Curriculum integration significantly improves behavioural engagement **(H3c)** |

*Notes:* Mean ± SD indicates the average self-reported score (1–5 Likert scale); $r$ = Pearson correlation coefficient; β = standardised regression coefficient; **H3a, H3b and H3c** results collectively demonstrate that curriculum integration positively predicts attitudes, awareness and behaviours, with all paths statistically significant ($p < 0.01$).

education missions. Consistent with **H3b**, curriculum integration also demonstrated a significant influence on students' awareness of sustainability issues (β = 0.29, $t = 5.43$, $p < 0.01$). This suggests that structured exposure to sustainability content enhances students' understanding of environmental and social challenges, supporting national and international agendas such as the United Nations Sustainable Development Goal 4.7, which emphasises the role of education in advancing sustainability literacy. Comparable findings have been reported in studies from other Asian and European countries where sustainability-integrated curricula have been shown to strengthen critical engagement with sustainability challenges (Cotton et al., 2007).

With respect to **H3c**, the results indicate that curriculum integration significantly predicts sustainable behaviours (β = 0.38, $t = 6.72$, $p < 0.001$), demonstrating that curricular exposure can translate into concrete pro-sustainability actions. This outcome reinforces evidence from international studies showing that competence-based sustainability education promotes behavioural engagement by linking knowledge with practice (Barth & Rieckmann, 2012; Jalaludin, 2025). Similar patterns have been observed across universities in Europe and Asia, where curriculum-wide sustainability integration has led to increased student participation in resource conservation and sustainability initiatives (Filho et al., 2024). Collectively, these findings confirm that curriculum integration functions as a multidimensional policy-aligned driver of sustainable education outcomes. By strengthening awareness, shaping attitudes and facilitating behavioural change, sustainability-integrated curricula support institutional sustainability strategies and

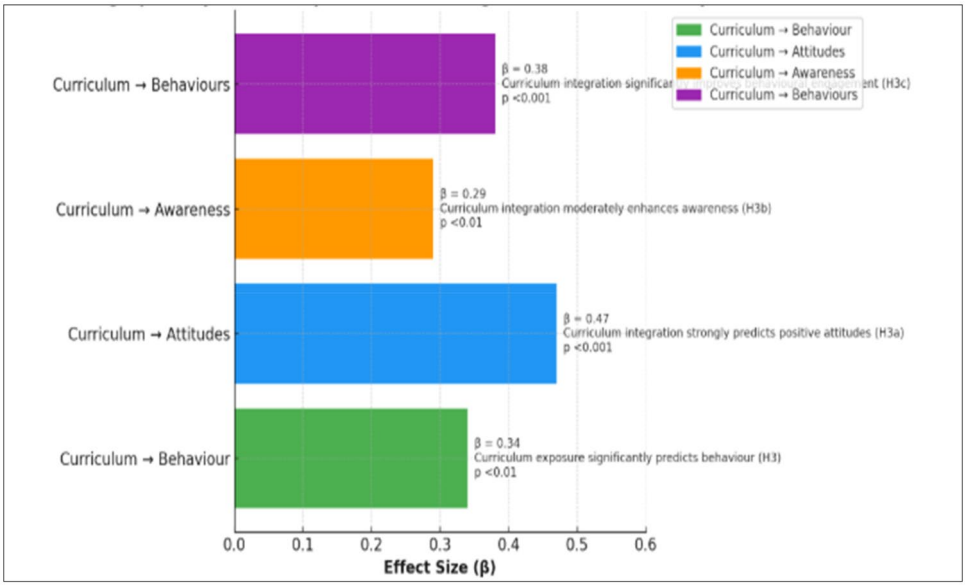



**Figure 14.** Summary showing how curriculum integration impacts sustainability outcomes.

national education-for-sustainability agendas, positioning universities as the active agents in broader sustainability transitions. Figure 14 summarises these relationships, illustrating that curriculum integration exerts its strongest influence on attitudes (effect sizes-β), while also significantly improving behaviours, enhancing awareness and driving overall sustainability engagement.

## 6. Recommendations and implications for policy and practice

Based on the study's findings, several recommendations are proposed to enhance sustainability awareness, attitudes and behaviours among students while strengthening the role of higher education institutions in fostering a sustainable future.

- Curriculum-Wide Integration of Education for Sustainable Development (ESD): Sustainability principles should be embedded across all faculties and disciplines as a core component of institutional education policy. This ensures that all students, regardless of academic background, acquire sustainability competencies consistent with SDG-4.7, including critical thinking, ethical reasoning and systems thinking.
- Experiential and Practice-Oriented Learning: Universities should expand experiential learning opportunities such as campus-based sustainability projects, community partnerships and problem-based learning to enable students to apply sustainability knowledge in real-world contexts. Such approaches are central to ESD and support the translation of awareness and attitudes into sustained behaviour.
- Student and Community Engagement for Global Citizenship: Active student participation through peer-to-peer learning, student-led sustainability initiatives and collaboration with local communities strengthen ownership of sustainability goals and reinforce the global citizenship dimension of SDG-4.7.
- Institutional Policy and Enabling Environments: Higher education institutions should establish supportive governance frameworks, incentives and infrastructure, such as sustainability policies, green campus investments and recognition schemes to reduce structural barriers and foster consistent pro-sustainability behaviours.
- Multi-Stakeholder Collaboration: Strengthening partnerships among educators, administrators, students, policymakers and external stakeholders enhances shared responsibility and amplifies the societal impact of ESD initiatives.

By adopting these policy-aligned strategies, universities can operationalise SDG-4.7 through education, moving beyond awareness-raising to cultivate graduates who are not only sustainability-literate but also empowered to contribute meaningfully to sustainable development at local, national and global levels.

## 7. Limitations and future research

While this study provides valuable insights, certain limitations must be acknowledged. First, the reliance on self-reported data introduces the possibility of social desirability bias, which may have influenced the accuracy of students' reported awareness, attitudes or behaviours. Second, the study was limited to a single sample and institutional context, which constrains the generalizability of the findings to broader cultural or educational settings. Third, the cross-sectional design restricts causal inference, as the dynamic relationships among awareness, attitudes and behaviours may evolve. To address these limitations, future research should adopt longitudinal designs to track behavioural changes and evaluate the long-term impact of curricular interventions on students' sustainability practices. Comparative studies across multiple institutions and cultural contexts are also recommended to capture the influence of diverse environments on student engagement. In addition, mixed-methods approaches that integrate quantitative surveys with qualitative interviews could provide richer insights into the motivations, barriers and contextual factors shaping the attitude–behaviour relationship. By pursuing these directions, future studies can advance understanding of the mechanisms through which higher education fosters environmentally responsible graduates and contributes to a sustainable campus culture.

## 8. Conclusion

This study demonstrates that students' awareness of campus sustainability initiatives is strongly associated with the development of positive sustainability attitudes; however, a substantial gap persists between these favourable attitudes and the consistent adoption of sustainable behaviours. This finding reinforces a central challenge identified in sustainability education: awareness and attitudes, although essential, are insufficient on their own to ensure sustained behavioural change. Crucially, the results show that integrating sustainability into university curricula plays a transformative role in narrowing this attitude–behaviour gap. Students exposed to sustainability-integrated curricula exhibited higher levels of awareness, stronger pro-environmental attitudes and more frequent engagement in sustainable practices than those without such exposure. Structured educational approaches including interdisciplinary modules, experiential learning and project-based activities were particularly effective in translating cognitive understanding into practical action.

These findings directly support the objectives of the United Nations Sustainable Development Goal 4 (Quality Education), particularly Target 4.7, which calls for equipping learners with the knowledge, skills, values and competencies required to promote sustainable development and global citizenship by 2030. By empirically validating the AAB framework and demonstrating the moderating role of curriculum integration, this study highlights how higher education institutions can operationalise ESD within academic programmes. Furthermore, by providing evidence from a developing-country context, the study broadens the global discourse on sustainability education, which remains dominated by research from developed regions. The findings underscore the strategic role of universities as the key enablers of the SDGs. Embedding sustainability across curricula enables institutions to move beyond awareness-raising towards cultivating graduates who are not only sustainability-literate but also capable of consistent, meaningful action, thereby contributing to long-term societal and environmental transformation.

This study makes three major contributions to the literature. First, it empirically tests the AAB framework in the context of higher education, providing quantitative evidence of how awareness influences attitudes, and how these, in turn, relate imperfectly to behaviour. Second, it evaluates the moderating role of curriculum integration, offering clear evidence that structured educational interventions can enhance awareness, strengthen attitudes and translate them into sustainable practices. Third, by situating the analysis in a developing country context, the study provides regionally relevant insights that broaden global discourse, often dominated by studies in the developed nations (United Nations, 2015). Collectively,

these contributions refine theoretical understanding of the AAB model by incorporating curriculum integration as a critical explanatory factor, while also offering practical guidance for higher education institutions. For policymakers, educators and administrators, the results underscore the importance of embedding sustainability across academic programmes. By doing so, universities can cultivate a generation of students not only knowledgeable about sustainability but also equipped to engage in consistent, meaningful action – ultimately advancing the broader goals of sustainable development.

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## Authors' contributions

CRediT: **Agboola Oluwagbemiga Paul**: Conceptualization, Methodology, Writing – original draft, Writing – review & editing; **Ilke Ciritci**: Data curation, Formal analysis, Methodology, Resources, Software, Validation; **Abdulaziz Alsharif**: Project administration, Supervision, Visualization, Writing – review & editing.

## Institutional review board statement

The study was conducted in accordance with the Republic of Turkey's regulations and approved by the Ethics Committee of Istanbul Gelisim University Rectorate Ethics Committee Presidency (Decision No: 2025-05-33), dated 14 March 2025.

## Informed consent statement

Written informed consent was obtained from all subjects involved in the study.

## Disclosure statement

No potential conflict of interest was reported by the author(s).

## Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author used Grammarly and ChatGPT (GPT-4) to improve readability, spelling and grammar. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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## Data availability statement

The original contributions presented in this study are included in the article/supplementary material. Further inquiries can be directed to the corresponding author(s).

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