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RESEARCH ARTICLE

# Green campus awareness in cross-cultural contexts: Analyzing national and gender differences between Korean and Indian university students

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## ABSTRACT

This study aims to compare and analyze the perceptions of green campus initiatives among Korean and Indian university students, with a particular focus on the influence of nationality and gender in five key areas: environmental awareness, environmental behavior, perceived need, willingness to participate, and support for green campus policies. A total of 94 participants were surveyed, including Korean students majoring in Indian Studies and Indian students majoring in Korean Studies. SPSS 21.0 was used to analyze the significance of nationality and gender differences using independent t-tests and two-way ANOVAs. The results showed that female students had significantly higher levels of environmental awareness and behavior compared to male students, and Indian students consistently outperformed their Korean counterparts in all five domains, with a mean score difference of more than one point, especially for willingness to participate and policy support. While the gender-nationality interaction effect was not statistically significant in most cases, the study found strong country-specific effects. This suggests that environmental awareness and engagement are deeply influenced by the broader sociocultural and policy context. These findings highlight the importance of developing culturally tailored and gender-specific educational programs to promote sustainability in higher education.

***Keywords:*** green campus; environmental awareness; sustainability; gender differences; cross-national comparison; South Korea; India

## 1. Introduction

As climate change and environmental pollution have emerged as serious global threats, the pursuit of sustainable development has become a key challenge for modern societies. According to the Intergovernmental Panel on Climate Change (IPCC) Synthesis Report of the Sixth Assessment Report released in 2023, about half of the world's population lives in areas that are highly vulnerable to climate change, and these changes are having serious impacts on ecosystems and human society. In this context, universities are recognized as more than just educational institutions; they are key agents in shaping future societal leaders while fulfilling their environmental responsibilities to their communities[1]. In particular, higher education is positioned to contribute to sustainable development through research, education, and

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community engagement[2].

Against this backdrop, universities are increasingly seen as central institutions in the realization of a sustainable society, and the concept of a "Green Campus" is gaining global attention as a concrete strategy to achieve this goal. The Green Campus concept is a comprehensive framework that encompasses technological and policy-based approaches such as environmental management, sustainable construction, and renewable energy utilization. It is also a focal point of discussions on the environmental responsibilities and roles of universities[3-5]. Universities play a pivotal role in addressing climate change and environmental pollution through education, research, and community collaboration, and Green Campuses serve as practical platforms for such sustainable development initiatives.

Green Campuses aim to create and maintain environmentally sustainable campuses through the collaborative engagement of university stakeholders, covering areas such as energy efficiency, waste management, green architecture, and environmental education[6-7]. This approach is characterized by an integrated perspective that considers not only environmental preservation but also economic and social sustainability[8]. Recent studies have emphasized that the environmental awareness and behaviors of campus members are critical factors in implementing Green Campus initiatives, beyond merely improving physical infrastructure[9-10]. It has also been argued that achieving a sustainable campus requires not only hardware solutions but also educational interventions that foster awareness and behavioral change[11].

Interest in Green Campuses is growing rapidly, particularly in Asian countries where fast-paced economic growth and urbanization have heightened environmental concerns. Countries such as South Korea, Japan, China, Malaysia, and India have introduced Green Campus initiatives and are implementing various programs aimed at energy conservation, greenhouse gas reduction, and sustainable campus development[12-13]. However, differences in socio-cultural contexts, environmental policy orientations, and educational systems across these nations lead to divergent perceptions and practices related to Green Campuses[14-15].

South Korea, as a member of the Organization for Economic Co-operation and Development (OECD), has developed systematic environmental policies alongside its rapid economic growth. However, public awareness of environmental issues emerged relatively late during its industrialization process. Since the 2000s, with the rise of sustainable development and green growth agendas, national Green Campus initiatives have been actively promoted, and many universities are participating by introducing environmental management systems, energy-saving programs, and green architecture[16]. In contrast, India faces severe environmental challenges due to rapid economic development and urbanization but possesses a cultural tradition that emphasizes harmony with nature[17-18]. Some Indian universities are making efforts to incorporate environmental education and sustainability into their curricula[19].

These national and socio-cultural characteristics can significantly influence university students' environmental perceptions and behaviors[20]. In other words, cross-national differences in environmental awareness are shaped by various factors, including levels of economic development, educational systems, cultural values, and the maturity of environmental policies. This suggests the necessity for context-sensitive approaches in the implementation of Green Campus models. Moreover, gender differences in environmental awareness are consistently reported in the literature, with women generally exhibiting greater concern for environmental issues and higher intention and engagement in pro-environmental behavior compared to men. These differences stem from multiple sources, such as socialization processes, value formation, and gender role expectations, indicating that gender-responsive approaches to environmental education and Green Campus programs may be more effective[21-22].

Based on these concerns, the present study aims to investigate differences in Green Campus perceptions between Korean and Indian university students, with a particular focus on national and gender differences. Unlike most prior research, which has focused on a single country or institution, this study contributes to a deeper understanding of how cultural contexts shape environmental awareness by comparing students in two distinct Asian societies. Furthermore, it explores how gender-based differences in perceptions vary across national and cultural contexts, thereby expanding knowledge on sociocultural influences on environmental attitudes. Finally, by segmenting Green Campus perceptions into five domains (Environmental Awareness, Environmental Behavior, Perception of Necessity, Willingness to Participate, and General Opinions) this study seeks to identify the structure and characteristics of perception differences. Such insights may contribute to setting policy priorities and developing more effective strategies for future Green Campus initiatives.

# 2. Literature review

## 2.1. Green campus research

Green Campus refers to the principle that universities aim to achieve environmental sustainability across all dimensions of their activities, including education, research, operations, and community engagement—and the concept began to spread globally in the 1990s[23]. Initially, Green Campus efforts focused on reducing the environmental impact of campus facilities by improving energy efficiency and waste management. Over time, however, these initiatives have evolved into a more holistic and integrated approach that encompasses curriculum reform, research innovation, governance transformation, and enhanced collaboration with local communities[24].

While Green Campuses are often seen as an extension of earlier eco-campus or environment-friendly campus movements, the contemporary notion of a "Green Campus" has developed into a strategic framework aimed at actively promoting a low-carbon society and achieving carbon neutrality[25]. Whereas earlier usage of "eco" or "green" mainly emphasized greening of spaces and general environmental protection, the current focus includes proactive institutional actions to combat climate change and reduce energy consumption[26].

In 1978, the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the United Nations Environment Programme (UNEP) jointly launched the International Environmental Education Program (IEEP), which first introduced the concept of sustainability into higher education. Since then, international declarations—such as the Talloires Declaration (1990), the Halifax Declaration (1991), and the formation of the International Sustainable Campus Network (ISCN)—have stressed the ethical responsibility of universities to deliver sustainability education. These initiatives have also provided structured frameworks for universities to establish sustainability goals and exchange implementation experiences[27](p. 208) [28](p. 15).

Since the 2000s, the rise of the "Sustainable University" model, closely aligned with the Sustainable Development Goals (SDGs), has expanded the Green Campus agenda beyond environmental concerns to include social and economic sustainability[29](p. 31). The SDGs, adopted by the United Nations in 2015, provide a framework of 17 interconnected global goals with the aim of achieving a better and more sustainable future. In the context of higher education, several objectives are of particular pertinence. For instance, SDG 4.7 promotes education for sustainable development and responsible global citizenship; SDG 11.3 supports inclusive and sustainable urbanization through participatory planning; SDG 12.5 encourages waste reduction via prevention, reuse, and recycling; and SDG 13.3 calls for enhancing education and

awareness regarding climate change mitigation and adaptation. Within this shift, the Green Campus should be understood not merely as improving physical infrastructure for energy efficiency and emissions reduction, but also as incorporating institution-wide, action-oriented strategies such as energy-saving campaigns, environmental education programs, and the installation and maintenance of sustainable facilities[30].

As significant energy consumers and contributors to pollution within society, universities are expected to go beyond their educational function and take social responsibility in addressing environmental issues[31-32]. Students, as active members of these institutions, also bear a responsibility to engage in environmental issues[33]. In the face of climate change—the most pressing environmental challenge of the 21st century—universities must demonstrate leadership in greenhouse gas reduction, thereby drawing public attention and promoting behavioral change[34].

For instance, Harvard University, a member of the American College & University Presidents' Climate Commitment (ACUPCC), has implemented a systematic sustainability strategy through its Climate Action Plan and conducts annual assessments using the STARS (Sustainability Tracking, Assessment & Rating System) indicators developed by the Association for the Advancement of Sustainability in Higher Education (AASHE)[35]. This approach enables the university to operate an integrated sustainability framework, fostering voluntary participation and strengthening engagement with the broader community.

In South Korea, the "Green Campus Project" has been actively promoted since the mid-2000s under the leadership of the Ministry of Environment and the Korea Environment Corporation. In 2008, the Korean Association for Green Campus Initiative (KAGCI) was established to provide policy support and inter-university collaboration[36]. According to KAGCI, a Green Campus encompasses four core components: (1) establishing green governance, (2) building an eco-friendly campus, (3) providing infrastructure for sustainability education and research, and (4) promoting community outreach activities[37]. Some universities have experimented with expanding green spaces or constructing underground campuses[38-39], and more recently, activities such as adopting renewable energy systems, improving energy efficiency, and establishing greenhouse gas inventories have been implemented. However, many institutions still face low levels of voluntary participation and awareness among campus members, and the overall implementation remains insufficient compared to that of developed countries, particularly in terms of institutional support and policy integration[40-41].

In India, the Green Campus movement has evolved from a culturally rooted appreciation for harmony with nature[42], but systematic policy development and institutional support at the higher education level are relatively recent. In response, the Ministry of Human Resource Development (MHRD) introduced the Clean Campus Award in 2017 to encourage sustainable campus practices[43]. Furthermore, the National Assessment and Accreditation Council (NAAC) has incorporated environmental sustainability criteria into its institutional evaluation frameworks, providing momentum for progress[44](p. 7). Nevertheless, the absence of clear national mandates and measurable targets limits consistent implementation across institutions[45](pp. 7-8). These challenges are deeply connected to India's post-1991 economic reforms, which accelerated environmental degradation[46], and underscore the need for a comprehensive, multi-level approach that includes Green Campus initiatives as a key strategy[47].

## 2.2. Gender and cross-national research on environmental awareness

Research on environmental awareness among university students has primarily focused on the determinants of awareness[48], the relationship between awareness and behavior[49], and the effectiveness of environmental education[50]. In general, factors such as gender[51], major[52], income level[53], and cultural background[54] have been identified as key predictors of environmental awareness.

Gender differences in environmental perception have consistently been reported, with women generally expressing higher levels of concern and engagement with environmental issues compared to men[55]. These differences are often interpreted as arising from gender-specific socialization patterns that emphasize care and empathy, leading women to be more sensitive to communal and environmental concerns[56](p. 90). Another explanation suggests that because women have traditionally been responsible for household and community well-being, their risk perception regarding environmental threats tends to be higher[57](p. 324).

However, because these interpretations rest on gender role stereotypes, it is important to acknowledge that gender differences in environmental attitudes may not be fixed but fluid, changing with evolving gender identities and social roles. Furthermore, such differences vary across cultural contexts. For instance, a study conducted among urban residents in China found that, contrary to patterns observed in Western societies, Chinese women were less concerned about environmental issues than men[58](p. 94). A broader cross-national study across 22 countries also revealed that gender disparities in environmental awareness were significantly related to institutionalized gender equality, with more egalitarian societies showing narrower gender gaps in environmental concern[59](p. 678). These findings underscore the influence of social structures and value systems on the development of environmental awareness.

Gender differences have also been noted in environmental behavior. Women are generally more engaged in domestic and routine eco-friendly actions, such as recycling or conserving electricity, while men are more likely to participate in public-oriented environmental activism, such as joining advocacy groups or engaging in political activities[60-61].

Cross-national studies on environmental awareness have investigated the impact of cultural, socioeconomic, and institutional variables. Research using the New Environmental Paradigm (NEP) scale has found clear differences between developed and developing countries in environmental attitudes[62](p. 428). People raised in economically stable environments tend to prioritize post-materialist values, including environmental protection[63](p. 57). Therefore, residents of developed countries typically report higher concern for environmental issues. However, recent research also shows that environmental awareness is rising rapidly in developing countries[64], suggesting a growing global consensus on the urgency of addressing environmental challenges such as climate change and ecological degradation. This indicates that firsthand experiences with environmental degradation or natural disasters may influence individuals' awareness in more immediate and tangible ways, beyond economic status alone.

Based on these insights, the present study aims to explore differences in green campus perceptions among university students in South Korea and India, two countries that differ significantly in terms of economic development and environmental challenges. Unlike prior studies limited to a single national or cultural context, this research takes a comparative perspective to investigate how cultural, policy-based, and experiential dimensions shape students' environmental attitudes.

South Korea, having experienced severe pollution during its rapid industrialization, is now a developed country and OECD member with relatively advanced environmental policies and technological capacity. Since the 2000s, government-led sustainable development strategies and the Green Campus project have supported university-level actions including energy conservation, greenhouse gas reduction, and green infrastructure development. Korean university students thus operate within an institutional environment that fosters awareness and participation through structural and social expectations.

India, on the other hand, is one of the fastest-growing economies in the world but faces severe environmental pressures due to its urbanization and industrial expansion. Despite having limited environmental management capacity, India possesses a longstanding cultural emphasis on harmony with

nature. In recent years, universities and government bodies have gradually begun promoting environmental education and Green Campus programs. Thus, Indian students' environmental awareness likely stems from a mix of cultural values and direct exposure to environmental crises.

The sharp contrast in socioeconomic development levels, environmental policies, and cultural backgrounds between the two countries provides a compelling basis for comparing students' environmental perceptions from multiple angles. By examining both national and gender-based differences, and their interaction effects, this study seeks to identify the multifaceted factors influencing environmental awareness.

Furthermore, the analysis breaks down Green Campus perceptions into five domains—Environmental Awareness, Environmental Behavior, Perception of Necessity, Willingness to Participate, and General Opinions. This structure enables a more nuanced understanding of how perceptions vary across dimensions, providing insight for developing culturally and contextually tailored strategies for campus environmental policies and programs.

Based on this framework, the study proposes the following research questions and a single testable hypothesis:

RQ1. Do Korean and Indian university students show significant differences in the five domains of green campus awareness (environmental awareness, environmental behavior, perceived necessity, willingness to participate, and general opinions)?

RQ2. Are there significant differences in green campus awareness levels based on gender (male and female)?

RQ3. How do country and gender jointly influence green campus perceptions, in light of environmental education contexts in South Korea and India?

H1. Female students and Indian students demonstrate significantly higher levels of green campus perception compared to male students and Korean students, respectively.

# 3. Research methods and instrumentation

## 3.1. Data collection and analysis methods

This study was conducted between May and June 2024, targeting two groups of university students majoring in language and area studies. In South Korea, data were collected from 52 students who were enrolled in a course taught by the researchers at Hankuk University of Foreign Studies. In India, 42 students majoring in Korean Studies at the Central University of Jharkhand (CUJ) participated in the survey, which was distributed with the assistance of the department head through official academic channels. The difference in sample size between the two groups reflects the variation in course enrollments and the voluntary nature of participation. The participants, all of whom were first- to third-year undergraduate students, were considered to be sufficiently comparable in terms of academic level and age range for the purposes of analysis. The demographic distribution of participants by nationality and gender is shown in **Table 1**.

**Table 1.** Demographic characteristics of participants by nationality and gender.

| | **Korean** | **Indian** | **Total** |
|---|---|---|---|
| Female | 34 | 15 | 49 |
| Male | 18 | 27 | 45 |
| Total | 52 | 42 | 94 |

Data were analyzed using SPSS 21.0, following a multi-step statistical procedure. First, Cronbach's alpha was calculated to assess the internal consistency of the questionnaire. Second, Kaiser-Meyer-Olkin (KMO) measure and Bartlett's Test of Sphericity were used to examine the suitability of the data for exploratory factor analysis, thereby validating the construct of the measurement scale. Third, independent samples t-tests were performed to identify significant differences in green campus awareness across gender and country. Fourth, descriptive statistics (mean and standard deviation) were used to summarize the distribution of responses. Finally, a two-way ANOVA was conducted to examine the interaction effects between nationality and gender on each domain.

### 3.2. Questionnaire and reliability

In this study, to assess university students' environmental awareness and their perceptions of green campus initiatives in Korea and India, a structured questionnaire was developed based on prior validated scales[65-68]. The questionnaire consisted of 25 items and was divided into five sub-dimensions: Environmental Awareness (A), Environmental Behavior (B), Perception of Necessity (P), Willingness to Participate (W), and Green Campus Support (S), where each item was measured on a 5-point Likert scale (1=not at all, 5=very much).

The Environmental Awareness dimension assessed participants' recognition of various environmental issues, such as the importance of environmental protection, the implications of global warming, the health consequences of air pollution, the value of recycling, and the necessity of conserving energy. The Environmental Behavior section focused on students' self-reported actions in daily life, including efforts to separate recyclables, reduce the use of disposable products, use public transportation and bicycles, save electricity, and purchase recycled goods.

The third domain, Perception of Necessity, was designed to evaluate students' beliefs about the importance of institutional efforts, such as establishing green campus policies, implementing energy-saving campaigns, offering environmental education programs, and developing infrastructure for environmental protection. The Willingness to Participate section captured students' motivation and intention to engage in environmental activities on campus, such as joining environmental clubs, volunteering in sustainability campaigns, proposing green policies, or taking part in related student projects. Finally, the Green Campus Support section measured participants' views on their university's current environmental efforts, their interest in green policies at other institutions, and their level of support for transitioning to a greener campus environment.

To examine the internal consistency of the questionnaire, Cronbach's alpha coefficients were calculated for each of the five subscales and for the total scale. The reliability results for each domain and the overall scale are presented in **Table 2**. The reliability of the overall scale was excellent ($\alpha = .937$), indicating a high level of internal consistency. Subscale reliabilities were also acceptable to high: Environmental Awareness (.697), Environmental Behavior (.723), Perception of Necessity (.852), Willingness to Participate (.919), and Green Campus Support (.876). Alpha values of .70 or higher are considered to indicate acceptable reliability[69](pp. 245-246), and in this study, the relatively high values for most subscales, particularly for Willingness to Participate and Green Campus Support, suggest that the items consistently measure the intended constructs.

**Table 2.** Reliability of questionnaire.

| Domain | Cronbach's Alpha | No. of Items |
|---|---|---|
| A. (Environmental Awareness) | .697 | 5 |
| B. (Environmental Behavior) | .723 | 5 |
| P. (Perception of Necessity) | .852 | 5 |
| W. (Willingness to Participate) | .919 | 5 |
| S. (Green Campus Support) | .876 | 5 |
| Overall | .937 | 25 |

In this study, the KMO measure and Bartlett's test of sphericity were conducted to determine whether the correlations between the survey items were suitable for factor analysis. As a result, the KMO value is .832, which is evaluated as 'meritorious', suggesting that the data is suitable for factor analysis[70], and Bartlett's test of sphericity is also significant with $\chi^2(300) = 1776.86$, $p < .001$, showing that the correlation matrix is statistically significantly different from the unit matrix (See **Table 3**). These psychometric results support the construct validity and internal consistency of the instrument, providing a robust foundation for subsequent statistical analyses of cross-national and gender-based differences in green campus perception.

**Table 3.** Kaiser-Meyer-Olkin measure and bartlett's test of sphericity for factorability.

| Measure | Value |
|---|---|
| KMO Measure of Sampling Adequacy | .884 |
| Bartlett's Test of Sphericity $\chi^2$ | 1433.85 |
| Df | 300 |
| p-value | < .001 |

# 4. Results and discussion

## 4.1. Gender differences in environmental awareness and behavior

Identifying gender differences in environmental awareness and pro-environmental behavior serves as a key foundation to enable evidence-based strategies in the development of environmental education programs and policies[70]. In general, women tend to have higher levels of sensitivity and involvement in environmental issues compared to men[71], and these gender differences support the need to understand the sociocultural context of environmental behavior and the need for educational interventions that require differentiated approaches based on gender. The results of gender-based independent t-tests across five domains are summarized in **Table 4**.

**Table 4.** Gender differences in green campus perception scores by domain.

| Domain | Female (M ± SD) | Male (M ± SD) | T | p |
|---|---|---|---|---|
| A | 4.380 ± 0.312 | 4.191 ± 0.283 | 3.075 | .003 |
| B | 4.159 ± 0.321 | 3.969 ± 0.467 | 2.282 | .025 |
| P | 3.702 ± 0.770 | 3.822 ± 0.733 | -0.775 | .440 |
| W | 3.327 ± 0.941 | 3.529 ± 1.052 | -0.980 | .330 |
| S | 3.355 ± 0.893 | 3.573 ± 0.849 | -1.214 | .228 |

In this study, statistically significant gender differences were identified in two domains: environmental awareness and environmental behavior. The results of an independent samples t-test indicated that the mean score of female students in the domain of environmental awareness (M = 4.38, SD = 0.31) was significantly

higher than that of male students (M = 4.19, SD = 0.28), t(92) = 3.08, p = .003. Similarly, female students also scored higher in environmental behavior (M = 4.16, SD = 0.32) compared to males (M = 3.97, SD = 0.47), t(92) = 2.28, p = .025.

No statistically significant gender differences were found in the domains of perceived necessity (t(92) = –0.78, p = .440), willingness to participate (t(92) = –0.98, p = .330), or green campus support (t(92) = –1.21, p = .228), suggesting that attitudes related to institutional support and policy engagement were similar across gender groups.

These findings are consistent with previous research that identified higher levels of environmental awareness and personal ecological behavior among women[73]. The interpretation of such gender differences has been linked to gender-specific socialization processes emphasizing care and communal responsibility[74]. Moreover, the higher environmental concern among women has also been explained by their traditionally assumed role in maintaining the health and safety of the family and community[75].

Therefore, this affirms that gender operates as a significant factor in shaping individual-level environmental awareness and behavior. These results indicate that the design of environmental education initiatives can benefit from the incorporation of gender-sensitive approaches that align with the differing motivational structures and social expectations associated with gender identity.

## 4.2. Differences in environmental awareness and behavior across countries

Although environmental issues present universal challenges on a global scale, the awareness and behaviors associated with them tend to be shaped by the unique sociocultural, economic, and political contexts of individual countries. As a result, examining cross-national differences provides an important basis for designing and implementing environmental education and policies that are responsive to local cultural conditions[76].

**Table 5.** T-test results by nationality.

| Domain | Korean (M ± SD) | Indian (M ± SD) | T | p |
|---|---|---|---|---|
| A | 4.200 ± 0.280 | 4.400 ± 0.315 | -3.212 | .002 |
| B | 3.927 ± 0.427 | 4.243 ± 0.305 | -4.182 | < .001 |
| P | 3.327 ± 0.641 | 4.295 ± 0.486 | -8.323 | < .001 |
| W | 2.827 ± 0.836 | 4.162 ± 0.608 | -8.957 | < .001 |
| S | 2.946 ± 0.802 | 4.095 ± 0.431 | -8.866 | < .001 |

The results of an independent samples t-test revealed statistically significant differences across all five domains of green campus perception between Korean and Indian university students (see **Table 5**). In the domain of environmental awareness, Indian students (M = 4.40, SD = 0.32) scored significantly higher than Korean students (M = 4.20, SD = 0.28), t(92) = –3.21, p = .002. Similarly, in the domain of environmental behavior, Indian students (M = 4.24, SD = 0.31) again outperformed their Korean counterparts (M = 3.93, SD = 0.43), t(92) = –4.18, p < .001.

Even greater differences were observed in the domains of perceived necessity (t(92) = –8.32, p < .001), willingness to participate (t(92) = –8.96, p < .001), and support for green campus (t(92) = –8.87, p < .001), with Indian students reporting substantially higher scores in each. Notably, in the domains of willingness and support, Indian students scored on average more than one point higher on the 5-point scale than Korean students, indicating a distinct divergence in attitudinal orientation toward institutional and participatory aspects of sustainability.

Several contextual factors may help to explain these results. The overall higher levels of environmental awareness, behavior, and support for green campuses among Indian students may be influenced by the growing urgency of environmental issues in India, which have been exacerbated by rapid industrialization and urbanization [77](pp. 283-285). In addition, cultural values embedded in traditional Indian worldviews and religious philosophies—many of which emphasize harmony with nature—may contribute to stronger pro-environmental attitudes[78]. Given that environmental attitudes and behaviors are influenced not only by individual-level cognition but also by broader sociocultural dynamics[79], it is plausible that the observed differences reflect the interaction of environmental conditions and culturally shaped environmental values in each country.

## 4.3. Interaction effects of gender and country on environmental awareness and behavior

The analysis of interaction effects between gender and country on environmental awareness and pro-environmental behavior has been considered essential for advancing both theoretical understanding and practical implementation of targeted environmental education programs[80]. It has been argued that this approach enables a more nuanced understanding of how gender-related patterns differ across cultural settings, thereby supporting the design of contextually and demographically tailored educational strategies. Prior research has also emphasized the importance of considering cultural variation in the gender-environment relationship in multinational studies[81]. These perspectives align with contemporary environmental education research that advocates multifactorial explanatory frameworks beyond single-variable analysis.

**Table 6.** Two-way ANOVA by gender and nationality.

| Domain | Factor | Sum of Squares | df | Ms | F | p-value |
|---|---|---|---|---|---|---|
| | Gender | 1.5711 | 1 | 1.5711 | 22.3561 | 0 |
| A | Nationality | 1.6671 | 1 | 1.6671 | 23.7227 | 0 |
| | Gender × Nationality | 0.1842 | 1 | 0.1842 | 2.6207 | 0.109 |
| | Gender | 2.0602 | 1 | 2.0602 | 17.4313 | 0.0001 |
| B | Nationality | 3.5298 | 1 | 3.5298 | 29.866 | 0 |
| | Gender × Nationality | 0.3879 | 1 | 0.3879 | 3.2824 | 0.0734 |
| | Gender | 0.6944 | 1 | 0.6944 | 2.0979 | 0.151 |
| P | Nationality | 22.1406 | 1 | 22.1406 | 66.8875 | 0 |
| | Gender × Nationality | 0.1757 | 1 | 0.1757 | 0.5309 | 0.4681 |
| | Gender | 0.9273 | 1 | 0.9273 | 1.6886 | 0.1971 |
| W | Nationality | 41.3739 | 1 | 41.3739 | 75.339 | 0 |
| | Gender × Nationality | 0.3887 | 1 | 0.3887 | 0.7078 | 0.4024 |
| | Gender | 0.3667 | 1 | 0.3667 | 0.8242 | 0.3664 |
| S | Nationality | 29.9277 | 1 | 29.9277 | 67.2605 | 0 |
| | Gender × Nationality | 0.0159 | 1 | 0.0159 | 0.0358 | 0.8504 |

The results of the two-way ANOVA indicated statistically significant main effects of both gender ($F = 22.36$, $p < .001$) and country ($F = 23.72$, $p < .001$) on environmental awareness. However, the interaction between gender and country did not reach the conventional threshold for statistical significance ($F = 2.62$, $p = .109$). Nonetheless, when adopting a more lenient significance level ($\alpha = .10$), a trend toward interaction was observed, which corresponds with prior findings that suggest gender-based differences in environmental values may be moderated by cultural context[82] (p. 358).

In the environmental behavior domain, both gender ($F = 17.43$, $p < .001$) and country ($F = 29.87$, $p < .001$) again had significant main effects. The interaction effect ($F = 3.28$, $p = .073$) approached significance at the .10 level, suggesting a possible trend. This is consistent with previous studies proposing that the manifestation of gender differences in environmental behavior may vary across cultures[83] (p. 94).

In contrast, only the main effect of country was statistically significant in the domains of perceived necessity ($F = 66.89$, $p < .001$), willingness to participate ($F = 75.34$, $p < .001$), and green campus support ($F = 67.26$, $p < .001$). Neither the gender factor (respectively: $F = 2.10$, $p = .151$; $F = 1.69$, $p = .197$; $F = 0.82$, $p = .366$) nor the interaction effect (respectively: $F = 0.53$, $p = .468$; $F = 0.71$, $p = .402$; $F = 0.04$, $p = .850$) reached statistical significance in these domains. These findings support theoretical frameworks suggesting that willingness to participate in environmental initiatives and support for institutional policies may be more strongly influenced by macro-level cultural and national factors rather than by gender alone[84] (p. 248).

Overall, the results indicate that both gender and national background significantly influence environmental awareness and behavior. However, in domains related to institutional support and participatory intention, country-level factors appear to exert greater explanatory power. This pattern supports integrative models of environmental behavior that emphasize the interaction between individual dispositions and sociocultural context[85] (p. 147).

# 5. Conclusions and limitations of the study

This study analyzed how perceptions of green campus vary by country and gender among university students in South Korea and India, focusing on five dimensions: environmental awareness, environmental behavior, perceived need, willingness to participate, and policy support. The findings confirmed that both gender and country serve as significant explanatory factors in shaping pro-environmental attitudes and behaviors, especially in the domains of awareness and behavior.

Gender-based analysis revealed that female students scored significantly higher than males in both environmental awareness and pro-environmental behavior, aligning with previous research that highlights gendered patterns in ecological engagement. However, no meaningful differences were found in other areas such as perceived necessity or policy support, suggesting that gender may play a more prominent role in individual attitudes and actions rather than institutional perspectives. Cross-national comparisons revealed an even more pronounced pattern: Indian students consistently outperformed their Korean counterparts across all five domains, with particularly large disparities in willingness to participate and support for green campus policies. These substantial differences are likely to reflect broader contextual influences, including environmental urgency, cultural worldviews, and educational priorities, which shape national attitudes towards sustainability. The overall findings indicate that national context exerts a more consistent influence than gender across most of the dimensions examined. This emphasizes the need for policy frameworks that are responsive not only to demographic characteristics but also to the sociocultural realities of each country.

Despite its contributions, the study has several limitations. The sample was limited to students from specific majors and institutions, reducing the generalizability of findings. Moreover, the reliance on self-reported data may introduce bias, and the cross-sectional design does not capture changes over time. Future research should expand to include more diverse national and institutional contexts and adopt longitudinal or mixed-method approaches to explore the long-term impact of environmental education.

## Author contributions

For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used "Conceptualization, T.K.; methodology, T.K. and Y.K.; software, T.K.; validation, T.K. and Y.K.; formal analysis, T.K.; investigation, T.K.; resources, T.K. and Y.K.; data curation, T.K.; writing—original draft preparation, T.K. and Y.K.; writing—review and editing, T.K. and Y.K.; visualization, T.K. and Y.K.; supervision, T.K..; project administration, T.K.; funding acquisition, Y.K. All authors have read and agreed to the published version of the manuscript."

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## Conflict of interest

The authors declare no conflict of interest.

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# Appendix A.

Survey Instrument: Items Measuring Perceptions and Behaviors Related to Green Campus Initiatives

| Domain | Items |
|---|---|
| A (Environmental Awareness) | A1. I believe that environmental protection is an important issue. |
| | A2. I think that global warming is a serious problem. |
| | A3. I am aware of the health impacts of air pollution. |
| | A4. I understand the importance of separating waste for recycling. |
| | A5. I am knowledgeable about the need for energy conservation. |
| B (Environmental Behavior) | B1. I separate waste for recycling in my daily life. |
| | B2. I strive to reduce the use of disposable products. |
| | B3. I use public transportation or ride a bicycle. |
| | B4. I make efforts to reduce unnecessary electricity use. |
| | B5. I prefer products that can be recycled. |
| P (Perception of Necessity) | P1. I believe that our university needs Green Campus policies. |
| | P2. I think it is necessary for our university to transition to an eco-friendly campus. |
| | P3. I believe our university needs energy-saving campaigns. |
| | P4. I think our university should have environmental education programs. |
| | P5. I believe our university needs to build infrastructure for environmental protection. |
| W (Willingness to Participate) | W1. I am willing to participate in environmental protection activities if they are established at our university. |
| | W2. I am willing to join an environmental protection club on campus. |
| | W3. I am willing to volunteer for campaigns aimed at environmental protection. |
| | W4. I am willing to provide my opinions on environmental policy proposals at our university. |
| | W5. I am willing to participate in projects related to environmental protection. |
| S (Green Campus Support) | G1. I think our university should make more efforts towards environmental protection. |
| | G2. I believe our university has the potential to develop into an eco-friendly campus. |
| | G3. I am interested in the Green Campus policies implemented by other universities. |
| | G4. I have ideas about what should be done to improve our university's environmental issues. |
| | G5. I support ongoing changes towards a Green Campus at our university. |