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Exploring Environmental Awareness and Engagement among Teacher Education Students: A Case Study of a Private University in Karachi, Pakistan

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Abstract

Environmental sustainability and the role of higher education institutions (HEIs) in promoting sustainable practices have gained notable attention in recent years. HEIs are striving to engage students in sustainability efforts to change their perception and promote active involvement. Students are generally concerned about environmental sustainability but there are gaps in awareness. Therefore, the current study investigates the students' point of view regarding the institute's environmental sustainability (Decarbonisation) plan and their role in making the campus more sustainable. A mixed method approach was used for students of education in a private institution in Karachi. Questionnaires were distributed among all the students on the campus through an online survey form to collect quantitative data which was filled by 47 students out of 65 students with the response rate of more than 70%. Additionally, a focus group discussion was scheduled with five representatives of M.Ed, MPhil and PhD cohorts at the campus to gather qualitative data. The quantitative and qualitative data were analysed using descriptive statistics and thematic analysis respectively. The data indicates that most students are aware of the environmental issues and have suggestions for improving their campus to align with the university's sustainability goals. However, despite the students' awareness, the findings also highlight a need for more knowledge among them regarding the current practices and commitments of the university towards the environment and net zero. Overall, while the university has taken significant steps towards sustainability by establishing a decarbonisation plan, the level of environmental consciousness among students and their understanding of their role as future educators in promoting sustainability remains unclear.

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Introduction

Decarbonization refers to the process of reducing carbon dioxide (CO_2) emissions resulting from human activities, with the aim of mitigating climate change impacts (IPCC, 2022). Achieving significant decarbonization requires a marked reduction in the global production and consumption of fossil fuels, which are currently the backbone of the modern economic system (Erickson et al., 2020). The internationalization of the academic sector also contributes significantly to these emissions due to increased travel and energy use (Glover et al., 2018). To address this, universities and colleges can enhance the efficiency of built infrastructure and promote conservation among users, both of which contribute to reduced energy consumption on campuses (Faghihi et al., 2015). Conducting comprehensive analyses can help identify areas where behavioral changes are needed to reduce carbon footprints (Li et al., 2015).

Higher education campuses, with their large sizes, diverse populations, and varied activities, serve as microcosms for examining environmental impacts and are ideal settings for testing emission inventories and greenhouse gas (GHG) reduction strategies (Jain et al., 2017; Victor et al., 2018). Universities can set powerful examples for other organizations and governments by committing to sustainability efforts and demonstrating a willingness to combat climate change (Udas et al., 2018). Many universities and research centers are already volunteering to maintain inventories of their emissions to develop decarbonization pathways. For example, a study at the University of Shanghai found that the average annual carbon footprint per student was 3.84 tons of CO_2 equivalent, with 65% attributable to daily life, 20% to transportation, and 15% to academic activities such as studying. The top three contributors to the carbon footprint were dining (34%), showering (18%), and dorm electricity usage (14%) (Li et al., 2015).

However, efforts to achieve carbon neutrality in higher education institutions come with challenges and risks. A study examining 11 institutions that declared carbon neutrality highlighted that while these efforts represent a shift toward sustainability, they often underutilize new zero-carbon electricity solutions. Compliance with neutrality goals may foster behaviors that resemble regulatory adherence rather than true climate leadership and innovation (Barron et al., 2021). Universities can explore partnerships with local governments for sustainable transportation strategies and district heating, as well as implement renewable energy technologies like building-integrated photovoltaics, micro-wind turbines, rainwater harvesting, and ground-mounted PV systems (Victor et al., 2018; Horan et al., 2019). Travel and travel-related research activities remain significant sources of GHG emissions for academics, especially for fieldwork and conferences (Ciers et al., 2018). A study estimated that the average carbon footprint of attending a scientific event is around 3000 kg per participant (Tao et al., 2021). Additionally, the environmental footprint of information and communication technology (ICT) use is often overlooked. Reducing the use or quality of video for online conferencing, for instance, is proposed as a strategy to lower carbon emissions (Obringer et al., 2021).

General guidelines for carbon footprint calculation often do not consider the unique characteristics of institutions of higher education (Kiehle et al., 2023). There is a need for refining and standardizing methods for assessing Scope 3 emissions i.e., the indirect emissions that occur in an institution's value chain (Robinson et al., 2015). Achieving environmental sustainability in higher education requires an integrated, systematic approach to decision-making, investment, and management (Lozano & Vallés, 2007). A paradox exists where institutions with lower, realistic, and achievable targets may be penalized in league tables for perceived low ambitions,

despite their goals being more attainable. Many universities, particularly in England, are unlikely to meet their pledges, highlighting that current carbon management plans are not always reliable indicators of future performance (Robinson et al., 2015). Despite these challenges, universities are attempting to reduce their carbon footprints through initiatives such as smart energy monitoring and renewable energy generation, although a lack of a standardized framework persists (Kourgiozou et al., 2021).

Leadership commitment within academia is crucial for adopting sustainable development practices and signing declaration charters or initiatives (Lozano et al., 2015). Higher education institutions are increasingly called upon to integrate sustainable development into their operations, driven by national and international policies, events, and targets. However, the integration process often lacks a standard approach, with initiatives outweighing formal strategies and policies, leading to a predominantly bottom-up process. To effectively address sustainability, a combination of top-down and bottom-up processes is necessary (Shawe et al., 2019).

Furthermore, it is vital for higher education institutions to implement awareness campaigns and sustainable practices (Haque et al., 2023). Environmental seminars have been recognized as effective means to attract both students and authorities to engage in sustainable practices (Turan, 2019; Haque et al., 2023). Higher education institutions should strive to engage students more in sustainability efforts to change perceptions and promote active involvement. Therefore, this study aimed to explore students' environmental awareness and their roles as students and educators in promoting sustainability in a private higher education institution in Pakistan. The research questions guiding this study are:

Research Question 1. What are students' perceptions regarding current environmental issues?

Research Question 2. How do students envision their role in creating a more sustainable campus environment?

Research Question 3. How do students view the university's decarbonization plan?

Research Question 4. What are their recommendations to educational institutes on addressing environmental issues?

Literature

University Students' Perceptions Regarding Environmental Issues

Students are generally concerned about environmental sustainability, but there is a noticeable gap between their awareness and their actual sustainable practices (Genovese, 2022; Haque et al., 2023). Perceptions of environmental issues also vary among students. Higher education students recognize serious environmental problems such as clean water scarcity, pollution (air, water, and ocean), reduced biodiversity, and global warming. However, they often fail to connect these issues to their daily lives (Keinonon et al., 2016). This gap between awareness and action suggests a need for further education and awareness campaigns to promote sustainable behaviors among students (Haque et al., 2023). Moreover, studies have debated the effectiveness of environmental education courses on increasing students' awareness of

sustainable development. Tuncer (2008) found no significant impact from such courses, challenging earlier findings by Brody and Ryu (2006), which reported positive effects. This inconsistency points to the need for a deeper examination of how educational strategies can effectively promote sustainability awareness and behaviors among students.

University Students' Perspectives

Students can play a crucial role in addressing environmental challenges at universities. They bring unique perspectives and enthusiasm that can drive innovative ideas and initiatives towards sustainability (Pittman, 2004). When students are empowered to assess and improve university performance in sustainability, they emphasize minimizing environmental impacts and fostering a higher level of social commitment. Many students were of the view that education on sustainability can remarkably influence their behaviours and attitudes towards the environment. Students feel that including more sustainability-related courses in the curriculum is the need of the time (Jeong et al., 2015). Students, realising the need to gain knowledge about sustainability in universities, show a positive change towards the environment. Furthermore, a sustainable university not only strives for academic excellence but also integrates sustainability across teaching, research, community outreach, waste and energy management, and campus planning (Nejati & Nejati, 2013). Increasing student engagement in these areas is crucial for building a sustainable university environment.

Universities are instrumental in climate change mitigation efforts through comprehensive decarbonization plans. Da Silva et al. (2023) emphasizes the necessity of standardizing carbon footprint calculations, particularly for Scope 3 emissions, which include indirect emissions. Standardization can help universities collaborate more effectively and enhance their sustainability efforts. Correia et al. (2020) highlights the importance of involving students in sustainability initiatives, noting that understanding their perspectives is vital for shaping effective sustainability policies. Engaging students fosters a shared sense of responsibility, which is essential for the successful implementation of decarbonization strategies (Haque et al., 2023).

Role of Educators

Educators are crucial in promoting environmental awareness and sustainable behaviors among students. According to Pandey et al. (2022), educators can serve as role models who inspire sustainable practices through teaching and the design of educational activities. Ozden (2008) supports this view, indicating that teachers with positive environmental attitudes are more likely to influence their students to develop similar attitudes. To maximize their impact, educators need support and resources to enhance their environmental education skills, allowing them to effectively foster environmental consciousness and inspire sustainable actions among students. In conclusion, to achieve sustainability goals, higher education institutions must develop strategies that bridge the gap between student awareness and behaviour. This can be achieved through targeted educational activities and initiatives that align decarbonization objectives with student values, enabling collaboration and shared responsibility for sustainability.

Method

Research Design

This study employs a mixed-method approach to explore the perceptions of students regarding environmental practices and the decarbonization policy. According to Creswell (2009), using both qualitative and quantitative methods provides a more comprehensive understanding of research problems than relying on a single method. He states, "The problem addressed by social science researchers are complex and the use of either quantitative or qualitative approach by themselves is inadequate to address this complexity… there is more insight to be gained from the combination of both qualitative and quantitative research than either form by itself. Their combined use provides an expanded understanding of research problem" (p. 203). Additionally, mixed-methods approach are especially valuable when one seeks both breadth and depth in exploring complex social issues (Creswell & Plano Clark, 2018). Therefore, the quantitative part allowed the researchers to collect generalizable data on levels of environmental understanding and mindsets across the sample, whereas the qualitative part provided more in-depth insights into learners' reasoning and values of environmental policies. Within the mixed-method paradigm, a convergent design was chosen due to time constraints. In this approach, both qualitative and quantitative data are collected and analyzed separately and then merged to provide a holistic view (Fetters, Curry, & Creswell, 2013). The study was conducted at a private higher education institution in Karachi, Sindh, Pakistan. The educational department was selected as the research site due to its emphasis on advancing environmental education and the university's well-developed decarbonization plan.

Quantitative Methods

A quantitative cross-sectional survey design was employed to collect data. This design is suitable for gathering information from a sample that represents a larger population at a single point in time, allowing for the efficient collection of data in a relatively short period (Bryman, 2016).

The study utilized a census approach, considering all students from every academic program at educational department as the sample. This was appropriate due to the small size of the target population, ensuring comprehensive data collection. The total number of students and their distribution across academic programs are detailed in Table 1.

Table 1

Number of on Campus students in June 2023

S.No	Academic Programs	Masters in education (M.Ed)	Master of Philosophy in education (MPhil)	PhD In education	Total
01	Number of Students	29	29	07	65

Data was collected using a structured, close-ended questionnaire. The questionnaire was divided into four sections: participant demographics, environmental awareness, institutional policy, and campus reality.

Data was collected using a web-based survey method, which involved distributing a Google Form through existing WhatsApp groups specific to each cohort. Participants were asked to complete the survey within five days. The response rate was satisfactory, with 47 participants (72.3%) responding within the set time frame. To ensure the validity of the survey tool, it was first reviewed by three final-year students and then by a field expert, who provided extensive feedback that was incorporated into the final version.

The quantitative data was analyzed using the Statistical Package for Social Sciences (SPSS), version 2022. Data was coded, and questionnaire items were assigned values to facilitate analysis in SPSS (Nardi, 2018). Descriptive statistics, including frequency distributions, means, and bar charts, were used to analyze students' perceptions.

Qualitative Study

A qualitative exploratory case study approach was employed to delve deeper into the environmental and decarbonization plans of the university. The case study method was suitable as it is particularly effective for answering "how" and "why" questions and provides contextual relevance to the phenomenon under investigation (Yin, 2009). Purposive sampling was used to select participants who could provide the most information-rich data in a natural setting (Creswell, 2009). Six students from the quantitative study participants were selected, with one student representing each academic program. A total of five participants ultimately took part in the qualitative study.

Data was gathered through a focus group discussion (FGD). Before the FGD, each participant was individually briefed on the study's aim, and their consent was obtained. The discussion was conducted in a suitable location, adhering to predefined FGD rules, and was recorded with the participants' consent. The researcher facilitated the discussion using pre-selected questions, with additional probing questions posed as necessary as an open-ended questionnaire. These included: In your own words share your views about the current environmental issues; Is there a need for the decarbonization plan on campus?; Can educational institutes drive and promote such environmentally conscious plans? Can you implement such steps in your own context? If so, how? Role of students and stakeholders in environmental sustainability; and Recommendations for the campus to be more sustainable?

The qualitative data was analyzed thematically. The recorded FGD was transcribed, and initial themes were identified during transcription (Maxwell, 2005). The FGD data was then compared with the quantitative data to identify recurring themes. Codes were generated from the data, and these codes were merged under common headings to identify new themes. A template was developed to organize data and identify patterns, contradictions, and comparisons (Maxwell, 2005).

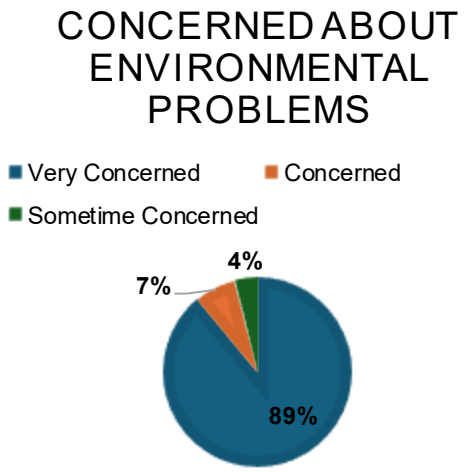
Ethical Considerations

Participants were assured of the anonymity and confidentiality of their responses. They were informed that their participation in the survey and FGD was not for evaluating their performance, and their responses would not be shared with the institution. All data were coded, and pseudonyms were used for the institution and individuals to maintain confidentiality. Data was stored on password-protected devices accessible only to the researchers.

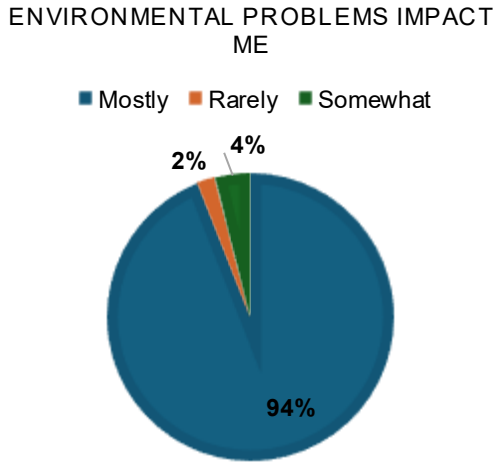
Figure 1

Student responses about concerns (a) and impacts of environmental events (b)

(a)



(b)



Results

Demographics

A total of 47 participants responded to a web-based survey. Of these, the majority were female (30) and 17 were male. The gender disparity reflects the higher enrolment of female students at the institute compared to males. Participants were predominantly from the province of Gilgit-Baltistan (22), with one from Punjab, 15 from Sindh, and 9 from Khyber Pakhtunkhwa. In terms of academic programs, there were 23 MPhil students, 22 M.Ed students, and 2 PhD students involved in this study.

Environmental Awareness

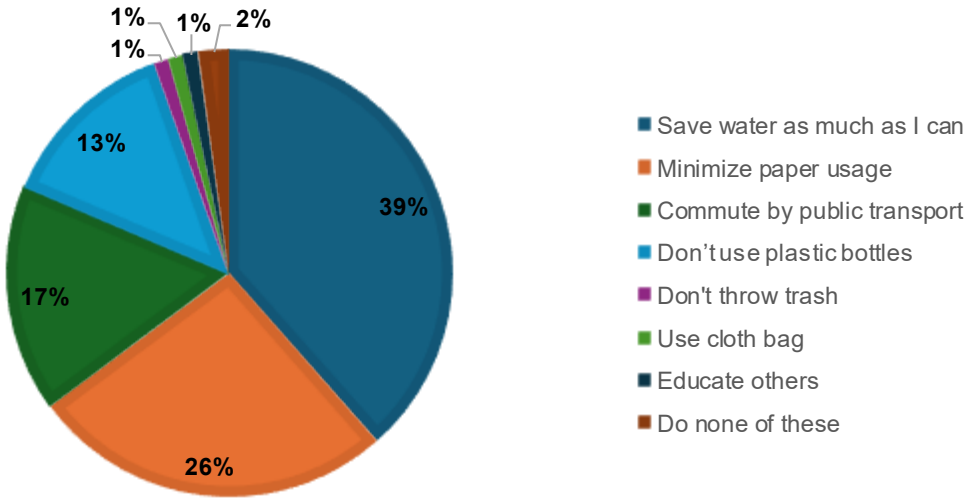
The survey data reveals that a significant majority (89%) of the students (Figure 1a) are highly concerned about environmental problems, with 94% indicating that these issues greatly influence their daily lives (Figure 1b). Only a small number of participants (2%) said they were rarely impacted by environmental problems and 4% indicated they were moderately or occasionally impacted. The term rarely was added for students who wished to show that climate change had little or no impact on their daily lives. This high level of concern is reflected in the actions students

are taking; 96% report that they are actively engaged in environmentally friendly behaviors, such as turning off lights and air conditioners when leaving a room (Figure 2).

Despite these positive behaviors, there is a noticeable gap in students' awareness of institutional policies. Only 32% of students are aware of the institution's environmental and decarbonization plan, and a mere 40% of those aware have read the plan (Figure 3a). Even more concerning is that among the students who have read the plan, only 53% believe it to be effective.

Figure 2

Environment friendly actions enlisted by the students

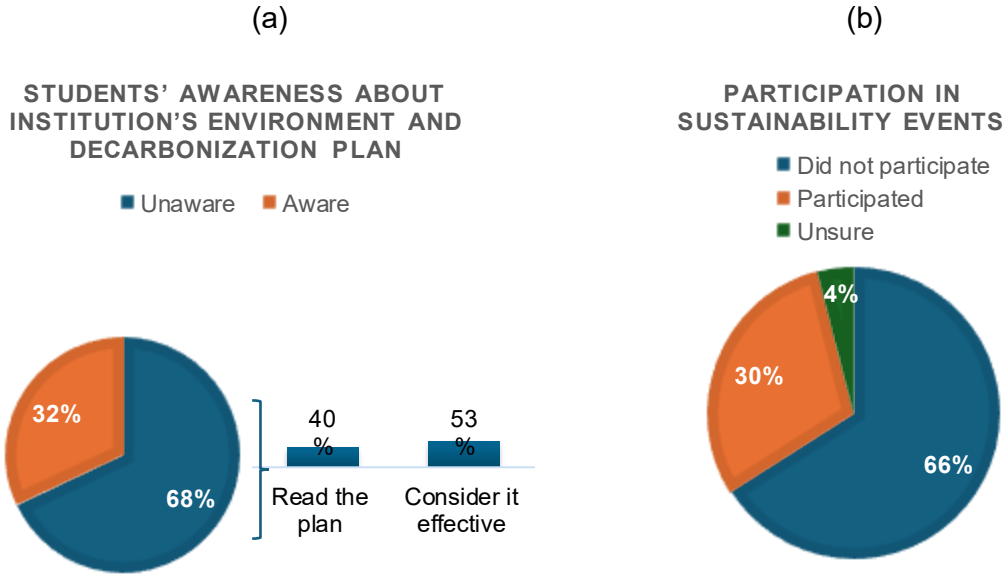


Participation in Environmental Initiatives

The data indicates a low level of student participation in the institution's environmental and sustainability activities. Only 30% of students participated in these initiatives, and 66% did not engage at all (Figure 3b). Similarly, 83% of students did not attend any orientation sessions on the environmental plan, despite 91% expressing a willingness to support institutional initiatives to protect the environment in future. However, it is also important to note that 7% were not interested in attending such events.

Figure 3

Student's awareness about decarbonisation plan (a) and their participation in environment and sustainability related events (b)



Campus Environmental Challenges

Students highlighted several environmental issues within the campus, including the excessive use of paper, plastic products, and the wastage of water and energy. The identified problems underscore the need for more comprehensive and enforceable sustainability practices within the institution. The solutions suggested by students include reducing paper usage through digital alternatives, banning plastic products, promoting the use of public transportation, and enhancing awareness and education on resource conservation. The student responses are summarized in Table 2. Please note that the campus has already banned the use of single use small plastic bottles and bags.

Synthesis of Qualitative Data

The focus group discussions reinforced the survey findings, highlighting a significant gap between awareness and action among students. Participants recognized the importance of integrating sustainability into daily life and educational curricula, stressing the need for clearer communication and accessible policies. There is some level of agreement that while students are concerned about environmental issues, the institution's current efforts to engage them in sustainability practices are inadequate. This calls for improved strategies to involve students in the decision-making processes and the execution of the environmental and decarbonization plan.

Table 2

Themes of problems identified, and solutions proposed by the students on campus

Category	Issues identified	Proposed Solution
Resource Overuse (water, food, paper, electricity)	Excessive use of paper	Promote digitalization, encourage mindful usage, implement double-sided printing, establish recycling systems.
	Water leakages in toilet seats	Fix water leakages
	No energy-saving bulbs in common rooms	Replace with energy-saving bulbs
	Water wastage	Promote mindful water use
	Waste of paper in cafeteria bills	Switch to an online billing system
	Overuse of tissue paper in the cafeteria	Raise awareness, reduce tissue usage
	ACs and lights left on when not in use, Excess use of AC	Encourage responsible use, raise awareness
	Overuse of meat in meals	Reduce meat consumption
	Food waste	Raise awareness about food waste
Campus Infrastructure	Lack of roof vegetation	Add green spaces on roofs
	Lack of green spaces	Establish more green areas in campus in general and hostels in particular
Plastic/Pollution/Waste Management	Use of plastic bottles and cups	Ban single-use plastics, encourage reusable bottles, improve waste segregation
	Garbage around campus	Raise awareness, improve waste management
	Use of disposable cups and glasses	Provide washable alternatives, install bins for plastic recycling
Pollution/Air Quality	Air pollution due to vehicle use	Encourage public transportation

Discussion

The findings of this study provide a comprehensive overview of the environmental awareness and engagement levels among students in the department. The results reveal a strong concern for environmental issues among students, with the majority acknowledging the significant impact of these issues on their daily lives. However, despite this concern, there is a notable gap in awareness and participation concerning institutional environmental initiatives, particularly the university's decarbonization plan.

Environmental Awareness and Actions

Studies indicate that student populations in higher education institutions (HEIs) generally exhibit high levels of concern regarding environmental issues (Kagawa, 2007). This finding is consistent with the results of the current study, in which 89% of respondents expressed deep concern about environmental problems, and 94% acknowledged the impact of these issues on their daily lives. Research by Alp et al. (2006) and Kollmuss & Agyeman (2002) supports the notion that such concern is often a precursor to environmentally responsible behavior. However, this concern does not always translate into meaningful engagement or systemic action. Tuncer (2008) also observed

that while students may demonstrate awareness of environmental challenges, their actions often remain limited in the absence of structured support and opportunities for involvement. In the current study, most students reported practicing individual pro-environmental behaviors, such as turning off lights and air conditioning, findings that align with Barr's (2007) research on micro-level environmental actions among youth. There is potential for a greater impact at the current university as it is accompanied by clear policy awareness and structural reinforcement.

Despite positive individual behavior, low awareness of institutional sustainability strategies is a consistent theme in literature. For instance, Sharp (2002) and Lozano (2006) emphasize that many students are unaware of or disconnected from institutional environmental policies. This was mirrored in the study at hand, where only 32% of students were aware of their institution's decarbonization plan, and only 40% of those had read it. This gap in awareness reflects broader issues identified by Velazquez et al. (2005), who argue that institutions often fail to effectively communicate sustainability goals and opportunities for student engagement. Emanuel and Adams (2011) also observed that a lack of effective communication often leads to low levels of student engagement in campus sustainability initiatives.

Participation in environmental initiatives remains another challenge. The current data shows that only 30% of students have been involved in such initiatives, despite over 90% expressing willingness to support them. This discrepancy is echoed in findings by Manteaw (2012), who observed that while students express strong environmental values, participation is hindered by limited opportunities, insufficient promotion of events, or a lack of integration with academic goals.

Barriers to Engagement

Research identifies institutional barriers such as weak policy implementation, infrastructural gaps, and insufficient stakeholder involvement as major impediments to sustainability in HEIs (Disterheft et al., 2015). The challenges identified in the current study, including excessive paper and plastic use, water and energy wastage, and limited green spaces, align with similar concerns reported in South Asian HEIs. Additionally, there is a perceived lack of accessibility and relevance of the plan to their daily lives and academic responsibilities. This disconnect is exacerbated by the top-down approach to policy implementation, which appears to limit student involvement in decision-making processes and reduces their sense of ownership and responsibility. This observation is supported by Genovese (2022), who argued that when sustainability initiatives are perceived as top-down mandates, students are less likely to engage meaningfully with them.

Students in the study proposed solutions like digitalization, improved waste segregation, and promotion of public transport, which resonate with best practices suggested in international literature on sustainable campus development (Cortese, 2003; Sibbel, 2009). However, a systematic review by Hajj-Hassan et al., (2024) showed that digital tools contribute to efficient learning in environmental education. Illustrating how gamified simulations, mobile applications, and interactive videos improve knowledge acquisition, enthusiasm, and engagement. Importantly, while digital tools offer immense benefits, the review also brings attention to the ecological footprint of ICTs themselves.

To address these challenges, the university needs to adopt a more inclusive and participatory approach to environmental sustainability. Simplifying the language of the decarbonization plan and making it more accessible to students could significantly improve understanding and

engagement. Furthermore, integrating sustainability into the core curriculum across all disciplines could help students see the relevance of these issues to their future professional roles and personal lives. The importance of curriculum integration is highlighted by Ozden (2008) and Jeong et al. (2015), who emphasized that when environmental education is embedded within the broader curriculum, it fosters a deeper understanding and long-term commitment to sustainable practices. The university should also consider organizing more interactive and practical workshops, seminars, and activities that actively involve students in the sustainability efforts on campus.

Policy Implications

The study underscores the importance of effective communication and the need for institutions to actively involve students in the formulation and implementation of sustainability policies. By doing so, universities can not only increase awareness and participation but also foster a culture of sustainability that extends beyond the campus. The university has the potential to lead by example in this regard, but it must first bridge the gap between policy and practice by engaging its students more effectively. This approach is supported by Pittman (2004) and Jeong et al. (2015), who noted that universities play a crucial role in modelling sustainable behaviours and that student involvement is key to achieving long-term success in sustainability initiatives.

Practical Implications

Students participating in this study suggested measures that the university can undertake to meet environmental needs and ensure environmental sustainability. Such suggestions demonstrate not only student consciousness but also their willingness to enable practical action. Some of the means suggested including encouragement of digitalisation of processes wherever it is practicable, a reduction in usage of paper by promoting printing from double-sided and electronic billing and proper recycling methods. Additionally, fixing water leakages and making use of energy-efficient light bulbs are necessary. They also advocated for encouraging proper use of water throughout the campuses including gardening. Students also recommended reducing unnecessary tissue usage, promoting food and meat awareness of consumption, and green space provision, including green roof space and hostel green space. Additionally, students stressed promoting the use of public transport to travel towards university in a bid to minimize carbon emissions. Such pragmatic guidance resonates with the requirement to integrate sustainability more intensively into university policy and practice.

Conclusion

In conclusion, while the students demonstrate a high level of environmental concern and a willingness to engage in sustainable practices, there is a significant gap in their awareness and participation in institutional environmental initiatives. To close this gap, the university must improve its communication strategies, simplify its policies, and adopt a more inclusive approach that actively involves students in its sustainability efforts. By doing so, the department and university can enhance its role as a leader in environmental sustainability within the higher education sector in Pakistan.

Overall, this study underscores the importance of involving students in the sustainability efforts of educational institutions, particularly in the decision-making process and the design of projects that

address environmental challenges. The university in particular, should prioritize making its decarbonization plan more accessible and understandable to all stakeholders by simplifying its language and clearly outlining individual roles and responsibilities. Integrating environmental education across all disciplines is also crucial to ensuring that students are well-equipped to contribute to sustainability efforts.

From a policy perspective, it is recommended that the university should establish a comprehensive framework that promotes sustainability across the entire university. This involves revisiting decision-making processes to encourage participatory approaches and ensuring that diverse perspectives are represented. By doing so, the university can set a precedent for other higher educational institutions in Pakistan, inspiring them to adopt similar practices and policies.

The feedback from the focus group discussions highlighted the need for ownership and collective responsibility in driving environmental sustainability. Teachers and educators play a critical role in embedding sustainability within the curriculum and school culture. Moreover, the decarbonization plan should be made more accessible, and awareness should be raised about the direct and indirect impacts of such initiatives. Establishing clear policies to guide behaviours and decisions is essential to align individual actions with broader sustainability goals.

Practical steps recommended by the respondents include reducing paper and plastic use on campus, promoting healthier and more sustainable food choices, and embracing digital alternatives to minimize waste. By implementing these recommendations, the university can enhance its role as a leader in sustainability, contributing to a more sustainable future for both the university and the broader community. The qualitative insights from the study emphasize the urgent need for a well-implemented decarbonization plan that is both accessible and actionable. Educational institutions are pivotal in fostering awareness and integrating sustainability into their curricula, thereby driving meaningful change and addressing environmental challenges in a sustainable manner.

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