INCREASE OF ENVIRONMENTALLY RESPONSIBLE BEHAVIOUR THROUGH EDUCATION AND TECHNOLOGICAL INNOVATION

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Abstract

Achieving climate neutrality by 2050 is among the European Union's highest strategic priorities, with public engagement and environmental education serving as fundamental components of this effort. This paper examines the significance of combining education, technological innovation, and behavioural methodologies to foster environmentally responsible behaviour within the university setting. At the Slovak University of Technology in Bratislava, a project was carried out in collaboration with industrial partners, aiming to enhance environmental awareness and promote behavioural change among students and staff. A central element of the project involved the administration of a questionnaire-based survey designed to assess environmental habits, attitudes, and the willingness of participants to engage in sustainability-oriented initiatives. The findings indicate a high level of environmental awareness and a strong willingness to support sustainable practices, particularly in the areas of energy and water conservation, waste management, and the adoption of renewable energy sources. The project underscores the vital role of integrating innovative technologies with educational strategies as effective tools in advancing climate neutrality within the academic environment. The main results of questionnaire are discussed in the paper.

Key words

environment, climate neutrality, questionnaire, renewable energy

Introduction

Climate neutrality has become a central theme of the European Union's environmental strategy, with a net-zero emissions goal set for 2050. This ambitious target requires profound transformation across sectors, including energy, transport, and industry. Achieving it demands not only technological solutions but also significant behavioural shifts within society. Public engagement is essential, as individual lifestyle changes directly impact policy success. Education plays a vital role in cultivating environmentally responsible behaviour. It empowers individuals to make informed choices aligned with sustainability goals. The Slovak University of Technology in Bratislava has responded to this challenge through a project focused on education and innovation. In collaboration other partners e.g. from industry and Slovak Academy of Science, the university aims to support behavioural change among students and staff. The project combines modern renewable energy education with digital tools. A baseline survey was conducted to understand current environmental attitudes. Results indicate strong awareness and willingness to act sustainably. Priorities include energy savings, water

conservation, and improved waste management. These insights form the foundation for targeted educational initiatives. The project demonstrates how universities can lead by example. It aligns with broader EU climate ambitions and promotes a sustainable campus culture. For better understanding of the students and academic staff meaning to the problematic of environment, climate neutrality and sustainability, the questionnaire with 20 questions addressed mentioned problems were prepared. A range of topics which include e.g. energy and water conservation practices, preferred modes of transportation, commuting distances to the university, and factors influencing transportation choices, as well as motivational drivers for adopting more sustainable mobility options. In addition, the survey assessed respondents' awareness of climate change and their interest in participating in environmental initiatives within the university context. The main results of questionnaire are shown and discussed in the paper.

1. Climate neutrality

The concept of climate neutrality is increasingly prevalent in contemporary discourse, particularly in relation to the European Union's strategic environmental goals. The EU has committed to achieving a net-zero emissions balance by 2050, a target that entails a comprehensive transformation across multiple sectors of the economy. This objective is to be realized not only through well-established approaches such as the expansion of renewable energy sources and improvements in energy efficiency, but also through the removal of carbon dioxide and other greenhouse gases from the atmosphere, via both natural processes (e.g., vegetation) and technological interventions.

A crucial component of this transition involves supporting the population in adapting to a greener economy, thereby acknowledging the socio-economic dimensions of climate action. Climate neutrality refers to a state in which a balance is maintained between the greenhouse gases emitted into the atmosphere and those that are removed or offset. This is accomplished through a combination of emission reductions, removals, and compensatory mechanisms, and it contributes to enhanced air quality and public health outcomes. The overarching aim of climate neutrality is to mitigate global warming and protect ecosystems.

Importantly, climate neutrality encompasses not only carbon dioxide (CO_2) but also other potent greenhouse gases such as methane (CH_4) and nitrous oxide (N_2O). The EU's commitment to achieving climate neutrality by 2050 was formalized through the European Climate Law, adopted in 2021, which also sets intermediate targets, including a 55% reduction in emissions by 2030 relative to 1990 levels. [1,2]

This objective forms a central pillar of the European Green Deal, a broad policy initiative designed to transform the EU's economy across key sectors such as energy, transport, agriculture, and industry. It incorporates targeted strategies like the Farm to Fork Strategy and the Circular Economy Action Plan, both of which aim to promote sustainability and reduce environmental burdens.

Furthermore, the European Commission has proposed an interim target of a 90% reduction in greenhouse gas emissions by 2040, compared to 1990 levels. This target serves as a critical milestone on the path toward climate neutrality by 2050 and underscores the urgency of accelerating decarbonization efforts over the coming decades. The transition to renewable energy sources remains a cornerstone of achieving these long-term objectives.

The active involvement of the population is crucial to the successful implementation of proposed measures addressing climate change, as these initiatives necessitate significant changes in individual behaviour, consumption patterns, and lifestyle choices. Without public

support, such transformations may encounter resistance; conversely, when individuals comprehend the urgency and rationale behind these changes, they are more likely to adopt climate-friendly practices—such as home insulation, reduction in consumption, waste separation, and the use of sustainable modes of transport. Accordingly, education and awareness-raising initiatives constitute essential instruments in facilitating a successful transition to a low-carbon society. [1,2,4]
Support for the green economy also manifests through consumer behaviour, particularly in the adoption of energy-efficient technologies and practices. The alignment of individual actions with broader environmental goals enhances the overall effectiveness of climate policies.

2. The results of the questionnaire survey at Slovak University of Technology in Bratislava

In response to the growing imperative to address the climate crisis and to fulfil commitments arising from both European Union directives and the Paris Agreement, an ambitious project was launched at the Slovak University of Technology in Bratislava (STU) in collaboration with industrial partners. This initiative aims, among other objectives, to evaluate the effectiveness of an educational programme and behavioural methodology targeted at students and university staff, with the overarching goal of contributing to or approaching climate neutrality at STU.
The project represents a synergistic integration of cutting-edge technological innovations, education, and empirical assessment, thereby offering a model for how academic institutions can play a leading role in the transition to climate neutrality.
Within the framework of the project, efforts are directed toward motivating individuals to adopt environmentally responsible behaviour. The educational programme is designed to be closely aligned with up-to-date information on advancements in renewable energy sources and related battery storage technologies. The project seeks to establish a link between innovative technological solutions and behavioural change, based on the premise that ecological habits can be encouraged, reinforced, and scaled through the implementation of smart technologies and digital infrastructure. Further information about the project is available at: www.rebecca.sk.
As an initial step toward encouraging individual engagement, a questionnaire-based survey was conducted with the aim of assessing the environmental behaviour and attitudes of students, academic staff, and other employees of the Slovak University of Technology (STU). The survey was carefully designed to yield a comprehensive understanding of daily habits, perceptions of sustainability, and the willingness of individuals to participate in environmental initiatives.
The questionnaire addressed a range of topics, including energy and water conservation practices, preferred modes of transportation, commuting distances to the university, and factors influencing transportation choices, as well as motivational drivers for adopting more sustainable mobility options. In addition, the survey assessed respondents' awareness of climate change and their interest in participating in environmental initiatives within the university context.
The survey also sought to capture respondents' views on potential institutional measures aimed at enhancing resource efficiency, their preferences for environmental activities that could be introduced at the university, and their opinions regarding the integration of sustainability-focused educational programmes into the formal curriculum.

The findings of the survey represent a valuable foundation for the development and implementation of strategies intended to reduce the university's carbon footprint. Furthermore, the data will serve as a mechanism for evaluating the effectiveness of the educational programme, particularly its capacity to encourage behavioural change in support of

sustainability. This methodology aligns with a broader academic trend that emphasizes the interconnection between technological innovation, environmental literacy, and the active engagement of university communities in the transition toward a more sustainable future.
A total of 101 respondents participated in the survey, with students comprising nearly 77% of the sample. Notably, only 2% of participants indicated a very low level of awareness regarding climate change and its implications for the planet. Similarly, only 2% of respondents reported either not feeling responsible or not actively contributing to the achievement of climate neutrality (see Fig. 1). These results suggest a generally high level of environmental awareness and a willingness to engage with sustainability initiatives within the university community.

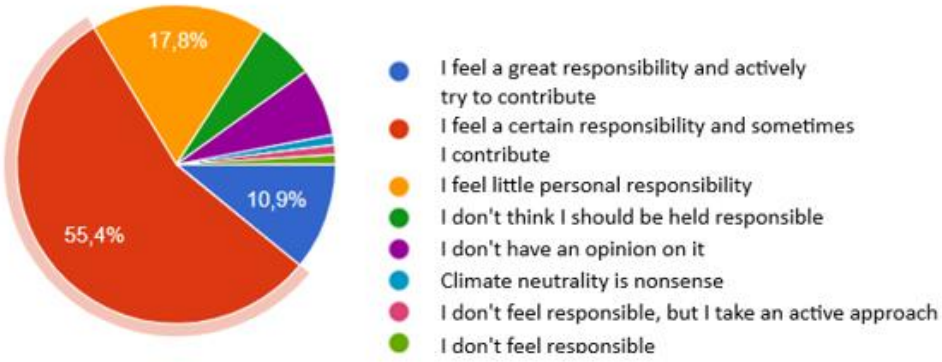

Fig. 1 Percentage distribution of answers to the question: How do you perceive your personal responsibility in achieving climate neutrality?

Among all respondents (101), 42.6% expressed agreement (responding “yes” or “rather yes”) with the proposition that sustainability education programmes should be integrated into university curricula. In contrast, 25.8% considered such integration unnecessary (“no” or “rather no”), while the remaining 31.7% adopted a neutral stance on the matter.
Given that the respondents come from technical institution, it may be reasonably assumed that both academic staff and students possess a relatively high level of awareness and understanding of topics such as energy efficiency, renewable energy sources, and energy consumption. In this context, responses to the question “*Which environmental topics should be prioritized at STU over the next five years*?” yielded particularly insightful results. Two topics were identified by more than 60% of respondents as priorities: the reduction of operational energy consumption and water conservation. These areas were also highlighted within the project as particularly urgent challenges. The third most frequently selected priority was the improvement of waste management systems, while 34.7% of respondents identified the adoption of renewable energy sources as a key area for future focus. Additionally, in response to the open-ended question inviting further suggestions or comments regarding environmental sustainability at Slovak technical University in Bratislava, several respondents proposed the installation of photovoltaic systems on faculty buildings, indicating a proactive interest in expanding the university’s use of clean energy technologies.

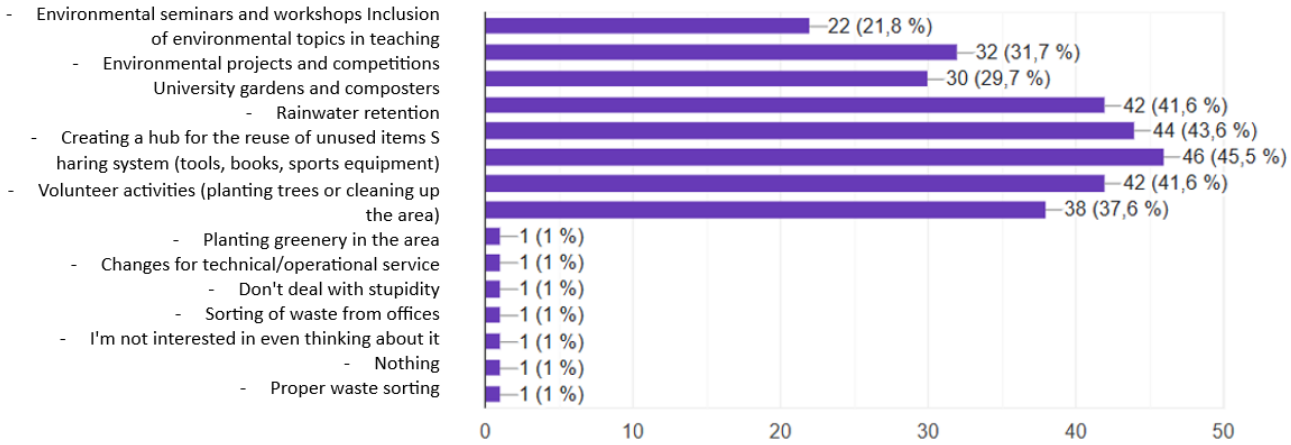

Fig. 2 Percentage redistribution of answers to the question: Which of the following environmental initiatives would you welcome at the university?

As many as 56.4% of respondents identified economic demands as the most significant barrier to achieving climate neutrality at university. Administrative complexity (41.6%) and technological limitations (40.6%) were ranked as the second and third most significant obstacles, respectively. Notably, only 1% of respondents believe that climate neutrality is unachievable, even in the absence of any barriers.

Responses to the question, *"Which of the following environmental initiatives would you welcome at the university?"* are presented in Figure 2. The option *"Volunteer activities (e.g., tree planting or environmental clean-ups)"* received a relatively high level of support. This indicates that respondents are not indifferent to the idea of contributing to a better environment. However, when asked, *"To what extent are you willing to get involved in STU activities and projects focused on sustainability?"*, 45.5% expressed a neutral stance, while 27.7% indicated they were very willing or willing to participate.

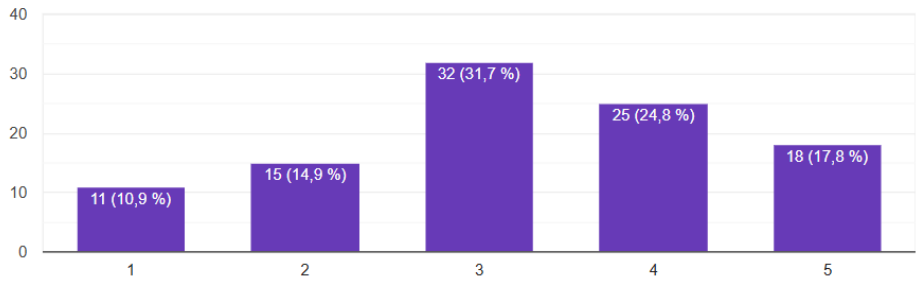

Fig. 3 Percentage redistribution of answers to the question: Do you think sustainability education programs should be part of university teaching? 1 – No, 5 – Definitely yes

When asked whether sustainability should be incorporated into educational curricula, approximately 18% of respondents indicated strong agreement, whereas nearly 11% expressed disagreement. The largest proportion of responses (31,7%) were neutral on the issue (see Fig. 3).

We would like to include a response to an open-ended comment provided by one of the participants: *"Let us act in an environmentally responsible manner, but we must also acknowledge the limitations of the idealized notions of 'green, sustainable, and carbon-free' behavior. In other words, I would first reconsider the terminology used, and I would caution against setting unrealistic expectations. In any case, it is essential to prioritize technical*

solutions that can deliver the greatest possible environmental benefit at the lowest possible cost."

Conclusion

The findings of the questionnaire survey conducted at the Slovak University of Technology in Bratislava confirm the critical role of education and technological innovation in advancing climate neutrality goals. The high level of environmental awareness among students and staff provides a strong foundation for the implementation of targeted sustainability initiatives. Respondents demonstrated a notable willingness to engage in environmentally responsible practices, particularly in areas such as energy and water conservation and waste management. These priorities are consistent with broader EU climate strategies and highlight the relevance of localized action within academic settings. A significant portion of participants also expressed support for integrating sustainability into formal university curricula, reflecting an openness to long-term educational change.

At the same time, the survey revealed certain barriers, notably financial constraints and administrative complexity, that must be addressed to ensure the effective implementation of environmental policies. The results underscore the importance of institutional support in overcoming these challenges and enabling behavioural transformation. Furthermore, respondents' suggestions, including the installation of photovoltaic systems, illustrate a proactive interest in the adoption of renewable energy technologies. While neutral attitudes were recorded in some areas, such as willingness to participate in university-led sustainability projects, this indicates a need for stronger motivational mechanisms.

It is essential to balance environmental ambitions with practical limitations, avoiding idealized expectations in favour of achievable outcomes. The integration of smart technologies with educational programming appears to be a promising pathway for fostering systemic behavioural change. This aligns with the broader objective of transforming university campuses into laboratories for climate innovation and responsible citizenship. The data obtained through this research offer a valuable basis for monitoring progress and guiding future interventions. Ultimately, the project reinforces the idea that higher education institutions have both the opportunity and the responsibility to lead by example in the global transition to climate neutrality.

Acknowledgement

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