EMISSION FREE EUROPEAN UNIVERSITIES

Strategic Development of Students' Sustainability Competences

in Engineering Sciences

Work Package #2

State-of-the-art analysis for universities

on their way to emission neutrality

Sustainability Awareness Report

DHBW Duale Hochschule Baden-Württemberg Stuttgart

Helsinki Metropolia University of Applied Sciences

Université Polytechnique HAUTS-DE-FRANCE

POLITÉCNICO DE LEIRIA

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Disclaimer

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List of Abbreviations

ECTS – European Credit Transfer and Accumulation System

EFEU – Emission Free European Universities

ESD – Education for Sustainable Development

DHBW - Duale Hochschule Baden-Württemberg (Baden-Wuerttemberg Cooperative State University)

FTEs – Full-Term Employees

HEIs – Institutes for Higher Education

IPL – Polytechnic Institute of Leiria

Metropolia - Metropolia University of Applied Sciences

SCF – Sustainable Competence Framework

SD - Sustainable Development

SDGs - Sustainable Development Goals

SDSR - Sustainable Development Social Responsibility

WPs – Work Packages

About this Publication

This publication presents the second of two reports from the second work package of the Erasmus+ Strategic Partnership project, "Emission Free European Universities" (EFEU).

The report provides the results of the sustainability awareness survey. It was administered to the staff and students at the project partners' universities to assess their sustainability awareness level. The overarching goal is to ensure partner universities implement actions that realistically and effectively address explicit and implicit deficiencies identified in sustainability teaching at their respective campuses.

This report is available via the project website at:

https://www.dhbw-stuttgart.de/forschung-transfer/technik/projekte/efeu/project-outcomes/

EXECUTIVE SUMMARY

The Emission Free European Universities (EFEU) project aims to enhance sustainability competencies and achieve carbon neutrality in engineering programs at four partner institutions: Baden-Württemberg Cooperative State University (DHBW-Stuttgart), Polytechnic Institute of Leiria (IPL) in Portugal, Metropolia University of Applied Sciences in Helsinki, and Polytechnic University of Hauts-de-France (UPHF) in Valenciennes. A key objective is to raise sustainability awareness among students and staff. To this end, the EFEU team developed the Sustainability Awareness Survey. The main objectives are to determine the sustainability awareness level of students and staff by evaluating knowledge and familiarity, attitudes and behavioural practices related to sustainability and to provide a foundation for improving sustainable education at partner universities. The survey will also be used to verify the hypothesis that higher educational levels have a positive impact on awareness level, attitude, and behavioural practices.

The survey, informed by literature on education for sustainable development and feedback from the project team, was conducted online from January 23rd to March 4th, 2024 via the Questionpro Platform. The results revealed that while participants demonstrated an acceptable level of awareness or familiarity with key sustainability concepts and positive attitudes towards sustainability assertions, these did not translate into sustainable behavioural practices. Participants gave a moderate assessment of their campuses, with close to 51% confirming that either they were extensively or adequately trained in sustainability and sustainable development topics. Both students and staff expressed dissatisfaction with the sustainability offerings at their universities, with only 44% of staff and 38% of students stating that they felt that their universities supported them in acting sustainably. The findings also demonstrated no direct correlation between increasing educational levels and sustainability awareness, attitudes, or behavioural practices.

Key considerations in the future development of the engineering programs were proposed, including greater engagement of administrative and lecturing staff, provision of ample training opportunities uniquely tailored and crafted to meet the sustainability demands of the job market and support the necessary attitudinal and behavioural shifts, and regular assessment of offered learning and teaching activities. These recommendations are intended to help partner universities align more closely with global standards in sustainable education and the evolving demands of the engineering field.

1 Introduction

Institutes of Higher Education (HEIs) serve as crucial pillars in shaping the trajectory of our society. They serve as hubs where individuals gain vital knowledge, skills, and perspectives for addressing current and future challenges. Of particular significance is the mandate outlined in the 2030 Agenda, which encapsulates the 17 Sustainable Development Goals (SDGs). HEIs are tasked with a dual responsibility: integrating the SDGs into their curriculum and research endeavours while acting as catalysts for societal transformation, thereby contributing to the realisation of the 2030 Agenda (REDS, 2020).

By incorporating the SDGs into their teaching and research at both graduate and undergraduate levels, HEIs equip students with the tools to address pressing global issues and foster a culture of sustainability and responsibility. Furthermore, as agents of societal change, HEIs actively engage with communities, industry partners, and policymakers to enact tangible initiatives that advance the goals of the 2030 Agenda. In fulfilling this dual role, HEIs serve as vital contributors to sustainable development, driving innovation, fostering collaboration, and empowering individuals to become agents of positive change in their communities and beyond.

Engineers are indispensable agents in driving the sustainable development of societies (Abd-Elwahed and Al-Bahi, 2020). Therefore, it is imperative to incorporate sustainability education into university curricula, particularly for engineering students, due to the vital role engineers play in enabling SD. To ensure partner universities are delivering learning that is effective at advancing sustainability within the engineering fields, it is essential that opinions on the quality of the curriculum, knowledge of key sustainability themes, behaviour/practices and perceptions/attitudes of students and staff be determined. The analysis of the results will facilitate the optimisation of efforts at the partner universities to improve the standards, performance, offerings, and ethos related to sustainable education.

1.1 Background: Challenges, Opportunities and Critical Activities

While many Higher Education Institutions (HEIs) have implemented policies, programs, and practices to promote sustainability, research indicates that university campuses still carry significant carbon footprints and other negative environmental impacts, presenting a challenge in meeting the goals of the 2030 Agenda.

This raises the critical question: How can universities accelerate the adoption of sustainable practices and integrate necessary changes into their educational activities to enhance overall sustainability performance?

Education plays a key role in preparing individuals to effectively generate and implement creative and sustainable solutions (Ariza et al., 2021). It equips individuals with the essential knowledge, values, and skills needed to become responsible environmental citizens. The EFEU project is pivotal in addressing this issue by offering impactful approaches to transform learning and teaching activities at the campuses of the partner universities and potentially other institutions of higher learning.

1.2 Project Partners

The project consortium is made up of four universities:

- the Baden-Württemberg Cooperative State University in Stuttgart (DHBW Stuttgart, Germany) as project coordinator and represented by the Department of Industrial Engineering & Management and the Department of Electrical Engineering;
- the Instituto Politécnico de Leiria (IPL, Portugal), represented by the Departments of Mechanical Engineering and Environmental Engineering;
- the Metropolia Ammattikorkeakoulu Oy (Metropolia UAS, Finland), represented by the Department of Real Estate and Building Services; and
- the Université Polytechnique Hauts-de-France (UPHF, France), represented by the Institute of Electronic Microelectronic Nanotechnology CNRS and the Institut National des Sciences Appliquées Hauts-de-France (INSA).

From December 31st, 2022, to May 30th, 2025, the Erasmus + Strategic Partnership, under the direction of the German Academic Exchange Service, will commit €250, 000.00 to ensure the successful execution of the project's activities.

1.3 Project Roadmap

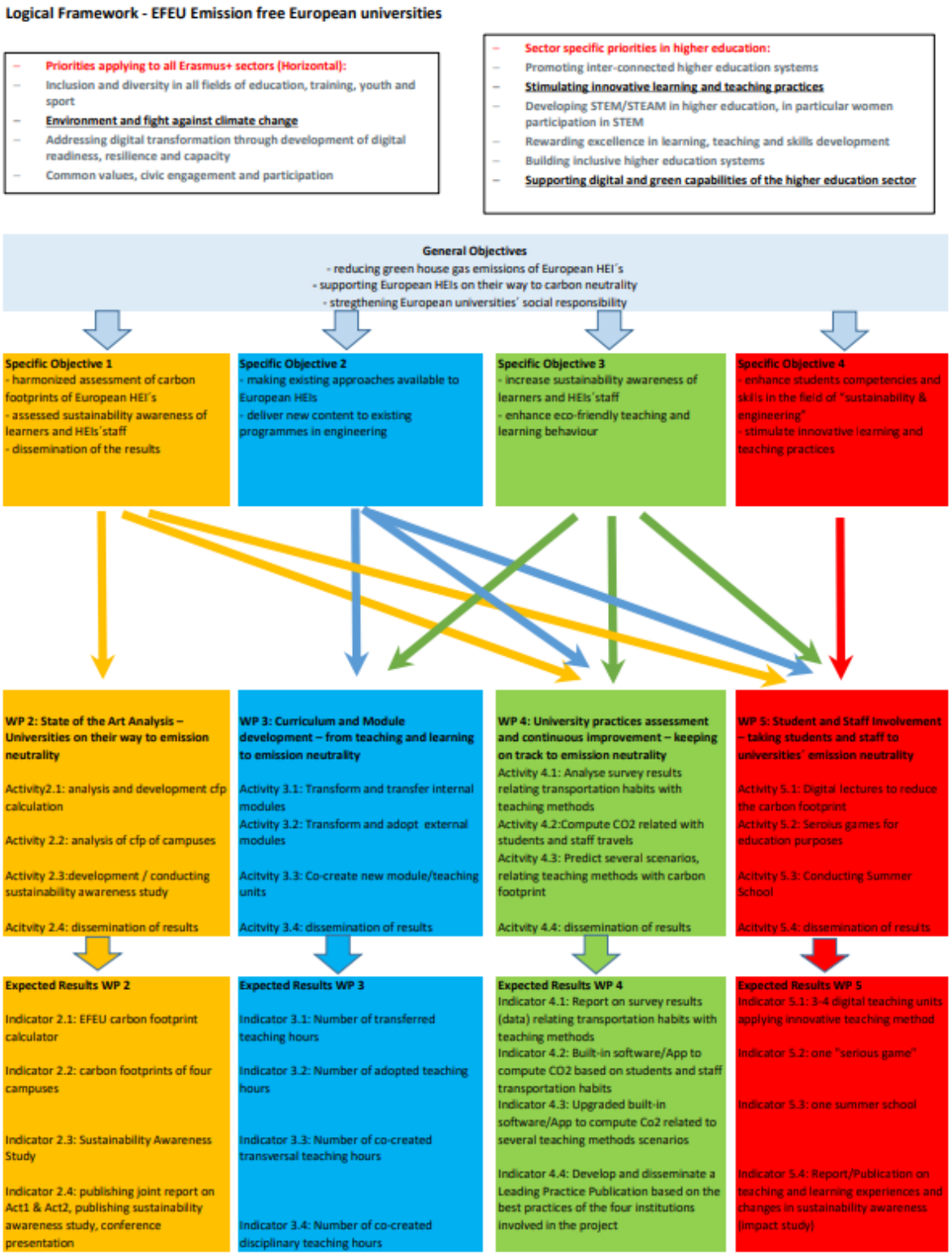

Figure 1: Project Overview EFEU – Work Packages

The project is structured into five work packages - WP (Figure 1). WP1 focuses on the project management activities. The leader of this WP is the DHBW, whom the project partners will strongly support. The objective of this WP is to ensure the utmost success

of the project's implementation through the hosting of project meetings, project tracking, documentation, quality supervision, budget control, time management, risk mitigation, communication and coordination, as well as ensuring inclusion and green practices are being promoted. Support from project partners is expected to ensure the timely and accurate submission of information related to project activities, results and progress, as well as financial matters.

The aims of WP2 are to gather information about the four partner universities' carbon footprint and assess the sustainability awareness of students and staff. The WP will begin with the research and revision of existing tools and end with the development of the EFEU Carbon Footprint Calculator. This tool, intended to be open source, will be used by partner universities and eventually by universities outside of the project consortium (dissemination and replication) to determine their carbon footprint during the use phase.

Accompanying the EFEU CFC will be a description of the methodology to support the utilisation of the calculator. This document will define the system´s boundaries, the means of collecting and processing data, and the necessary input values. Once the tool and the methodology are completed, partners will collect data about their university campuses and determine the carbon footprint of at least one university campus. The calculation tool should be seen as a tracker with which each university can monitor their levels of carbon emissions and track their progress in the implementation of sustainability strategies and climate targets. The carbon footprint assessment results will be used to develop the subsequent WPs' content.

The four partner universities will develop and administer a sustainability awareness survey. The results from the sustainability awareness assessment will be used to develop the content of WP3, WP4, and WP5 and, therefore, curricula, teaching methods, and learning activities. The results of the carbon footprint and sustainability awareness survey will be presented in an open webinar at each partner university and at one international conference.

The objectives of WP3 are to target, select, plan, and develop one of the core actions of the EFEU project – develop critical competences and skills of future mechanical,

electrical, industrial and business engineers in the field of sustainability. The outcomes will be critical to the planned activities of WP5. In the development of new teaching material (adoption of external examples or co-creation of brand-new content), two kinds of modules may be considered:

- Transversal modules that do not necessarily belong to a given program but can optionally be attended by any bachelor student, irrespective of the student's discipline (including humanities). This should be the primary target for co-developing a 3 to 5 ECTS module.
- Disciplinary modules that belong to existing programs. Generally, it will not be possible to create an additional module because programs have a fixed amount of teaching hours. In that case, it would rather be a retrofit of an existing disciplinary module in which the Sustainable Development Social Responsibility (SDSR) aspect is inadequately covered.

The outcome might be a short-time emphasis on SDSR aspects in various disciplinary modules, representing 20 % of the module contents. The hope is that this approach is practical enough to allow for implementation beyond the four partners.

The maturity of each partner in the many themes covered by the project will be assessed. A partner can be qualified as "uninformed", "aware", "beginner", "qualified", or "expert". WP3 will create the conditions to improve the SDSR maturity of every partner individually and of the EFEU consortium as a whole, employing:

- Combined actions (serial, parallel asynchronous, parallel synchronous);
- Transversal modules transfer, optimisation, adoption or creation from scratch;
- Representative disciplinary modules creation in different domains (mechanical engineering, electrical engineering, industrial engineering and business engineering), and
- Consolidation of best practices applied internally and disseminated externally.

WP4 will focus on the development and application of a built-in software to compute Co2 based on the students' and staff's mobility habits. To achieve these objectives, the following activities are planned:

- Consider and design relevant questions for the mobility survey to be integrated with the sustainability awareness survey.

- Analyse and compare how the teaching methods influence the carbon footprint, considering students' and staff's mobility habits.
- Create a digital platform that relates mobility choices with the carbon footprint. This platform will have built-in software to compute CO2e based on mobility habits.
- Motivate students and staff to use bicycles, public transportation, or walking based on information available on the platform, with some awards for the best practices.
- Motivate city councils to improve public transport access (improving the interconnection network), thus reducing transport fuel and promoting the transition to electric mobility.
- Develop and disseminate a Leading Practice Publication based on the best practices of the four institutions involved in this project.

The goal of work package 5 is to determine the best means of reducing the carbon footprint of teaching activities. Therefore, the objectives are as follows:

- Developing and conducting teaching concepts focused on reducing the carbon footprint;
- Using new digital formats so that virtual classes are more beneficial to students;
- Creating opportunities for student exchange within Europe that have a minimal carbon footprint; and
- Making experiences of this work package available to other stakeholders and universities.

Certain agreed-upon methodologies, proceedings, and approaches established by the EFEU team will be used in the execution of the EFEU project and the individual work packages. As the project progresses, more specific approaches will be chosen to implement activities forming part of these work packages. These methodologies, proceedings, and approaches are presented and discussed in the following chapter.

2 Methodology

This chapter covers the general methodologies and proceedings approved by the EFEU team for the development of the project activities and the execution of duties. It also provides more specific details on the approaches implemented for work package 2 and the development of this report.

2.1 EFEU Methodology

The Erasmus+ EFEU project adopts an exploratory approach to research and employs an action research methodology. The project consortium has devised a structured five-step process for implementation by utilising a mixed-method approach, resulting in five comprehensive reports and various implementations. Methodologies employed include literature review, qualitative and quantitative surveys, expert interviews, co-creation workshops, and piloting of teaching and learning events.

The initial phase entails an in-depth literature review to examine prevailing trends in carbon footprint calculators, sustainable awareness, educational practices, and mobility behaviours. Additionally, it encompasses the exploration of serious games addressing climate change, sustainability competence frameworks, curriculum analysis tools, Co2 computation and prediction software, and the examination of module catalogues from partner universities.

An online survey will be developed to assess sustainability awareness and mobility practices among students, lecturers, and administrative staff. Subsequently, the survey will be distributed and disseminated in the second phase. During this phase, the EFEU Carbon Footprint Calculator, along with the implementation methodology and set of pertinent indicators, will be created and piloted by the partner universities.

In the third phase, data collected from the survey will inform initiatives to foster sustainable learning. This will be complemented by a curriculum analysis to identify learning gaps and best practices, alongside co-creation workshops involving teachers, academic and industry experts, and practitioners to determine the requisite knowledge and skills for integrating sustainable practices into student curricula. In this phase, best practices identified in teaching and learning events will be transferred to the project partners.

In the fourth phase, data from the mobility survey will guide decision-making processes in enhancing and promoting sustainable mobility practices at individual campuses. Co2 prediction software will also be used to simulate future scenarios that analyse and compare teaching methods and carbon footprint. During the fifth phase, the EFEU serious game and EFEU digital modules will be developed and piloted during the EFEU summer school, and their impact will be evaluated through the implementation of an impact study.

Throughout the project, the transfer of learning activities will be encouraged to facilitate closer collaboration with project partners and nurture capacity-building among students and staff. Additionally, emphasis will be placed on dissemination activities to publicise the project outcomes and promote their potential use in academia and industry.

2.2 General proceedings of the EFEU Team

DHBW acts as Project Coordinator (PC), supervising the overall progress of the project. Its responsibilities include chairing the Steering Committee and consortium meetings; taking all actions to enable proper decision-making; supervising the consortium´s activities concerning administrative, financial, legal, and contractual aspects; monitoring the project planning and the delivery of project results; and submitting all required progress reports, deliverables and financial statements.

A DHBW research assistant will support Project Management (PM). This individual will manage the Consortium activity concerning administrative, financial, legal, and contractual aspects; ensure the effective operation of the project, the project website, and project communication mechanisms; coordinate the organisation of the Steering Committee and Consortium meetings; manage the repository of project documentation (deliverables, task reports, minutes of meetings, publication, etc.); and upload relevant documents and information to the project platform. On a local basis, the other partners will also set up coordinated PM processes.

The consortium intends to use MS Teams, which will be hosted by DHBW. An exclusive Team, “EFEU”, has been set up and will be used for regular meetings of the project core team and other planned or ad hoc meetings. DHBW will also provide a

secured project SharePoint. From the experience of former projects, social media—e.g., WhatsApp—has proven valuable as an informal and ad hoc communication tool between project members. Therefore, it will be utilised throughout the project duration.

A leader (s) has been designated for each WP. All project partners will support the WP leader and collaborate on each of the four content-related WPs

- Work Package 1; Work Package Leader: DHBW
- Work Package 2; Work Package Leader: Metropolia
- Work Package 3; Work Package Leader: UPHF
- Work Package 4; Work Package Leader: IPL
- Work Package 5; Work Package Leader: DHBW AND UPHF

The partners are aiming to distribute content-related workloads equally. Right from the beginning, all partners nominated/assigned sufficient staff, ensuring appropriate coverage of the expected workload. During implementation, the Project Core Team may vary from activity to activity, depending on individual expertise and the interest of the partners´ staff. Each partner is responsible for organising communication with local stakeholders and hosting or organising one physical transnational meeting and one multiplier event.

Figure 2 shows the format of regular team meeting.

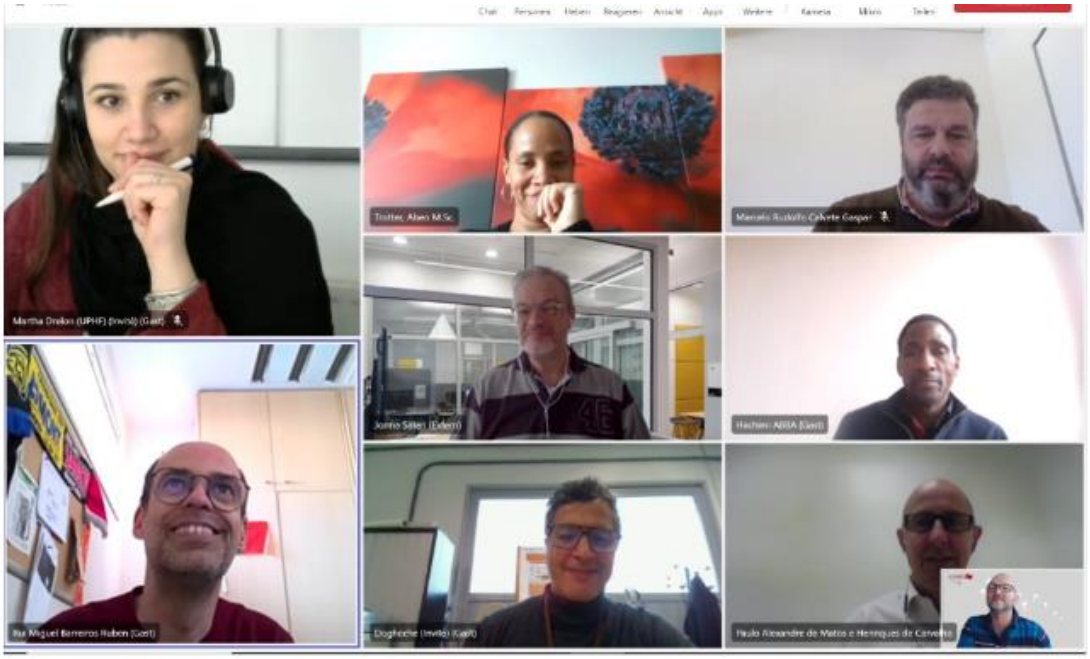

Figure 2: Online delivery via MS Teams

2.3 Methodology of EFEU Work Package #2

WP2's main objectives are to gather information about the actual carbon footprint of the university campuses and to assess staff and student awareness of sustainability themes. The results of these assessments will be used internally and disseminated externally.

University campuses are complex systems that encompass a large number of educational and management activities. The EFEU project will focus on developing a carbon footprint calculation tool that meets the needs for the assessment of university campuses. Evaluating the carbon footprint is vital for universities committed to carbon emission reduction targets or carbon neutrality targets. The tool can be used to track changes in the carbon footprint of universities, and having such a tool in use is indispensable to reaching those targets. Information about which activities are responsible for elevated greenhouse gas emissions will supplement efforts for the other WPs.

The EFEU survey aims to collectively evaluate sustainability awareness among students and staff. We seek not only to gauge awareness levels but also to engage students and staff in conceptualising and planning actionable steps to enhance campus sustainability, particularly in reducing carbon footprint.

The survey results will serve as a foundation for subsequent Work Packages (WPs), guiding the planning and implementation of activities involving students and staff. By incorporating their input and participation, we aim to foster a sense of ownership and commitment towards sustainability initiatives across the campus community.

2.4 Methodology - Development of the EFEU Sustainability Awareness Survey and Report

2.4.1 Study Design

This report follows a structured sequence of standard activities as shown in Figure 3. Initially, a comprehensive literature review was conducted to establish a theoretical foundation. This was followed by the systematic collection of data. The findings were then presented clearly and concisely. Subsequently, these findings were discussed, and recommendations were provided based on the analysis. Finally, the study was concluded with summarising remarks.

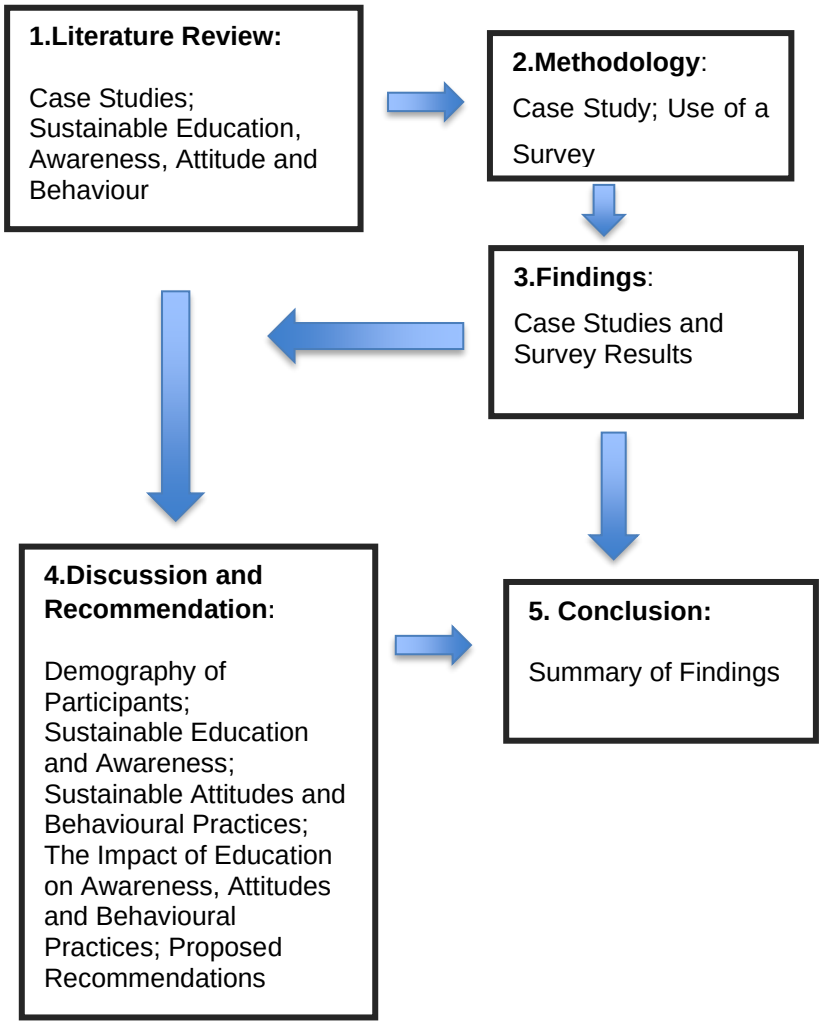

Figure 3: Study Design Matrix

2.4.2 Study Approach

This study takes an inductive approach, as findings will be used to develop a theory, solutions, or conclusions. Due to the objectives of the study, a quantitative approach was used. Quantitative research uses empirical assessment based on numerical measurements, and within the quantitative methods, the survey is the most commonly used data collection process (Abdus-Samad et al., 2020).

This study also involved the application of case studies. According to Robson (2002), a case study is a research strategy that involves an empirical investigation of a particular contemporary phenomenon within its real-life context. This strategy is relevant to the nature of this study as four partner universities are focused on determining the sustainability awareness level of their staff and students.

2.4.3 Study Development

First, the case studies were reviewed to determine the significant and distinguishable features of each campus. Subsequently, a literature review was undertaken to reveal reoccurring themes related to education for sustainable development and sustainability awareness. A prevalent theme in the literature is the relationship between sustainable education and awareness, behaviour/practices, and attitudes/perceptions. Consequently, these themes served as the basis for formulating the survey questions. Clarification of relevant terms and significant findings and arguments in the literature are provided in Chapter 3.

The development of the survey was also based on the insights and feedback of the project team members, whose backgrounds and experience with sustainability helped with the editing and finalising of the questions.

The survey consisted of both quantitative and qualitative questions and was divided into four major parts. The first part was dedicated to determining the socio-demographic background of participants, the second part was to verify experience/knowledge related to sustainability, the third part was to substantiate the knowledge of key sustainability concepts, and the fourth part was to gather data on the perceptions and practices related to climate change and sustainability

The survey was first developed in English and then translated into the languages of the project partners. It was only available online via the Questionpro platform. The survey was first tested with staff members from each partner university. The feedback was integrated to improve its usability and ensure its effectiveness.

The students and staff of the engineering faculties of partner universities were invited to participate via E-mail, intranet notification, and digital signage. Respondents had the opportunity to participate from January 23rd, 2024 to March 4th, 2024.

The results were analysed using Questionpro and Microsoft Excel's analytical tools and presented in various graphical formats. The data sets were then discussed by building on and exploring the theoretical framework to explore patterns, provide explanations, present key findings and offer suitable recommendations.

2.4.4 Ethical Consideration

To administer the survey, it was necessary to acquire permission in a transparent and voluntary manner from participants. Consequently, a General Data Protection Regulation statement was provided with the objectives of the research fully explained and a guarantee that acquired information will be treated with confidentiality.

3 Literature Review: Sustainability Awareness

3.1 Introduction

The relevance of assessing sustainability awareness is the first step in understanding the levels of knowledge that different groups of people possess concerning the severity of environmental problems and how they respond to or interact with their environment (Ziadat, 2010). Additionally, these assessments help professional educators understand, quantify, and establish educational environmental awareness programs to better address societal challenges (Jeong et al., 2021).

3.2 Sustainable Education and Awareness

The term ‘‘awareness’’ is used to imply a level of knowledge gained empirically through one’s perceptions. However, it can also be considered synonymous with ‘‘cognisance,’’ which is the recognition of something sensed or felt (Ziadat, 2010). Knowledge, on the other hand, goes beyond awareness and involves a deeper understanding of a subject through the result of learning, study, and experience (Cambridge University, 2024).

In realising the need to raise different levels of awareness and promote education, Goal 4 of the 2030 Agenda for Sustainable Development Goals (SDG 4) emphasises the need to equip all learners with the necessary skills and competences to promote sustainable development by 2030 (United Nations, 2024). This demand aligns with the education pillars developed by UNESCO, i.e. learning to know, learning to do, learning to be, and learning to live together (Ridwan et al., 2021).

Universities play an essential role in promoting sustainability awareness. As universities have the potential to develop new ideas regarding sustainability through research, teaching, and practices, they are essential stakeholders in fostering understanding and forging a way forward in achieving a sustainable future (Filho et al., 2016; Filho, 2017; UNESCO, 2017; UNCC, 2013).

Lozano et al. (2019) explained that these institutions must design highly effective, engaging, and relevant learning activities that foster knowledge transfer and enhance skills and competences. The goal is to contribute to the realisation of the sustainable

development goals (SDGs) and, therefore, the sustainable remediation of global challenges (Martinez et al., 2021).

To implement the concepts and topics related to SDGs in education, the UNESCO launched two highly recognisable initiatives: Global Action Programme (GAP) (2015 – 2019) and Education for Sustainability Development (ESD) (ongoing). The focus of these initiatives is to scale up action on ESD and to generate and scale up concrete actions in ESD (Braßler et al., 2021). Education for Sustainability Development (ESD) is focused on several dimensions: sustainable knowledge, behaviours, attitudes and awareness (Tschannen-Moran and Woolfolk-Hoy, 2001; Filho et al., 2016; Filho, 2017; Jeong et al., 2020). These dimensions are illustrated in Figure 4.

However, so far, only limited evidence is available on the quality and efficacy of the initiatives implemented by HEIs under ESD and GAP programmes in terms of knowledge, competences, attitudes, values, and behaviour (Rieckmann, 2018).

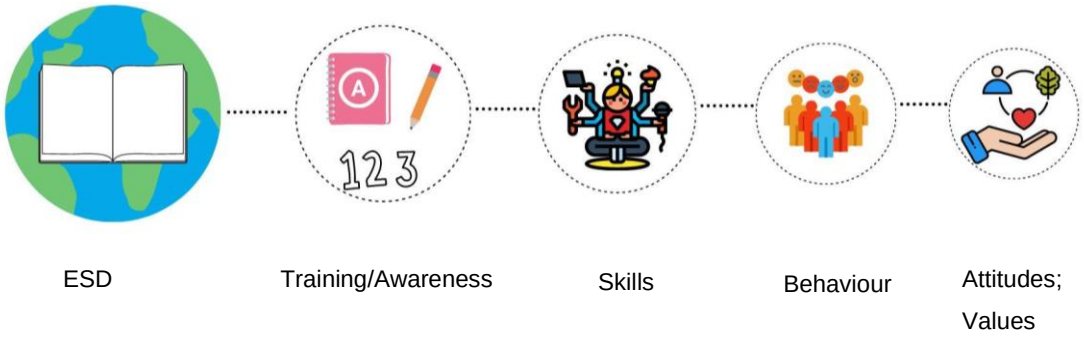

Figure 4: Dimensions of Education for Sustainable Development

3.3 Sustainable Attitudes

Attitudes reflect a person's cognitive and affective evaluation of a given object, behaviour, or situation and partially guide behaviour (Bozorgparvar, 2018; Kim et al., 2013). Contributing aspects to the formation of attitude are illustrated below:

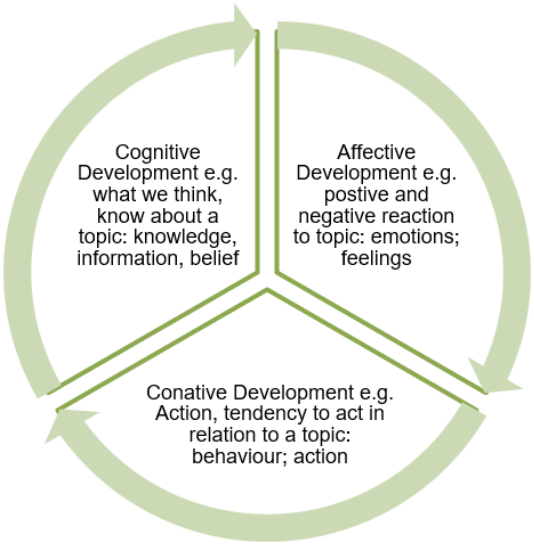

Figure 5: Contributing Aspects to The Formation of Attitude (Bakanauskas et al., 2020)

Environmental attitudes are a psychological tendency expressed by evaluating the natural environment with some degree of favour or disfavour (Milfont & Duckitt, 2010). Another related concept is sustainable attitudes, which refers to how individuals and groups perceive and prioritise sustainability in their daily lives and decision-making processes. Ambiguity and different perspectives have generated a diverse set of attitudinal measures (Milfont & Duckitt, 2010). For the purpose of this study, we will discuss sustainable attitudes by focusing on the following components: beliefs, concerns, and values. These three aspects were recognised by Milfont & Duckitt (2010) as core elements in attitudinal measures. Behaviour will be discussed later in this chapter.

Whether categorised as environmental or sustainable attitudes, they both rise and fall with current events and vary with factors such as age, gender, socioeconomic status, nationality, urban-rural residence, religion, politics, values, personality, experience, education, and environmental knowledge (Gifford et al., 2012).

For the purpose of this study, we will focus on the aspects of education and environmental knowledge. The literature has highlighted that increasing knowledge of sustainability could influence one's beliefs, values and intentions (Ajzen and Fishbein, 1980; Leiserowitz et al., 2005; Lacy et al., 2009; Perloff, 2016). The findings of Watling and Zhou (2011), Andersson et al. (2013), and Mifsud (2012), Tang (2018) support the notion that education and knowledge are instrumental in forming positive attitudes towards sustainability. However, other researchers such as Collado et al. (2020) and Jackson et al. (2015) argued that although education aims to improve environmental attitudes, results indicate that it is failing to have an impact or detectable correlation.

Another argument on sustainable attitudes is whether these lead to pro-environmental or sustainable behavioural practices. Several researchers (Wu and Mweemba, 2010; Heeren et al., 2016) argued that although many studies find positive associations of environmental attitudes with or influence on pro-environmental behaviours, other studies show non-significant, weak, or inconsistent relationships. This point was supported by (Carrington et al., 2014; Juvan and Dolnicar, 2014), who stated that positive environmental attitudes and intentions are, unfortunately, not always and entirely reflected in people's behaviour.

This environmental attitude-behaviour gap has attracted considerable attention among behavioural and cognitive scientists. Although many studies have been undertaken, we do not yet fully understand the mechanisms causing this discrepancy (Gifford & Chen, 2017; Wyss et al.,2022). These researchers underscore the importance of further studies in fully comprehending this complex relationship.

3.4 Sustainable Behavioural Practices

Pro-environmental behaviour (PEB), also known as green, sustainable, or environmentally friendly (eco-friendly) behaviour, is defined as behaviours in which individuals take protective actions toward the environment (Lee and Khan, 2020). Figure 6 illustrates the contributing factors to sustainable behaviour.

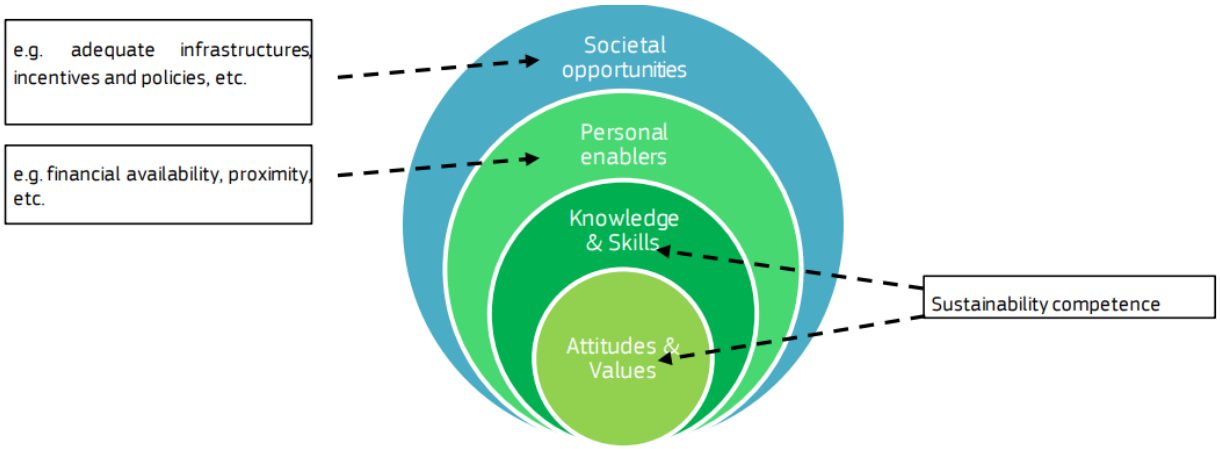

Figure 6: Sustainability Competences and Context for Sustainable Behaviour Performance (Rieckmann, 2012)

While behavioural practices are related to values systems and social, cultural, and demographic factors of individuals, education is identified as a significant determinant by several researchers, such as (Hamid et al., 2014 and Čiarnienė et al., 2020). A common assumption is that unsustainable behaviours are primarily driven by a lack of knowledge of the underlying societal costs of such behaviour (Singh et al., 2016).

However, Grilli and Curtis (2021) explained that although quantitative analysis of behaviour change interventions and outcomes shows that education and awareness are the most common behaviour change methods, these methods have the lowest success rate in the studies that they were examined. According to Poortinga et al. (2004), scientific evidence suggests that education and awareness campaigns are particularly effective when individuals are motivated by a pre-existing interest in environmental issues and willingness to engage in pro-environmental behaviours

As pointed out earlier in this chapter, pro-environmental attitudes do not always foster or translate to pro-environmental behaviour. The disconnect between attitude and behaviour highlights the need to identify some of the barriers to achieving sustainable behavioural change. The barriers to sustainable behaviour, according to Blake (1999), can be categorised into three types: individual barriers, responsibility and practicality.

Individual barriers refer to attitudes and temperament (e.g. laziness) and are particularly prominent in people with weak environmental concerns. Blake (1999) also explained that responsibility is where individuals do not engage in virtuous

environmental behaviours because of a lack of trust, which leads to a belief that individual behaviours cannot influence the situation. According to Blake (1999), the third barrier is practicality, which relates to how social and institutional impediments impact behaviour regardless of individual attitudes (e.g. lack of time, money and information). Dolnicar and Hurlimann (2010) draw similar conclusions, reporting that cost, convenience and practicality are the main barriers to positive behaviours.

To effectively affect behaviour, it is vital to determine the limiting factors and if these can be addressed to facilitate more sustainable practices. This notion is supported by (Dabija et al., 2017), who argued that literature focused on understanding the causes and impacts of key factors, including their linkages (environmental, education, social, etc.) in building sustainable behaviour, should be a focal area in curricula of universities all around the world.

3.5 Conclusion

Knowledge, values, and behaviours seem to be at the centre stage in the question of how to achieve transformations towards sustainability (Alroe et al., 2017). This view aligns with the conceptualisation of environmental citizenship provided by the European Network of Environmental Citizenship, which holds that an environmental citizen exhibits the will and competences (understood as the efficient integration of knowledge, values, dispositions, and skills) to actively participate in resolving and preventing sustainability problems (David and Maki, 2019). Suryawati et al. (2023) also argued that skill level, attitude, behaviour, and practices are integral in determining sustainability awareness.

Even though the relationship between knowledge, attitude, and behaviour is not necessarily linear, some studies, such as those by Roth (1992), Sia et al. (1986), and Hsu (2004), propose that individuals' attitudes and environmental behaviours reflect their environmental knowledge. In fact, Michaels et al. (2020) demonstrated in their study of Malaysian public institutions that final-year students have the highest level of sustainability awareness, attitudes, and actions compared with first-year and second-year students.

Despite the conflicting findings, it is widely recognised that higher education institutions are important places to develop the necessary perceptions and behaviour among future professionals towards SD, which ultimately paves the way for humanity to achieve the goals of SD (Michael et al., 2020). The intention of this study is to make the necessary shift through the effective use of available resources and approaches to further advance sustainable education within the engineering curricula of partner universities.

If left unattended and ignored, education for sustainable development (ESD) and its awareness among students can directly impact students' skills, abilities, and performance (Malik et al., 2019). Students need to be educated to build the required competence for addressing sustainability. However, implementing sustainability practices across all aspects of the university has proven difficult due to budget cuts, competing priorities, and demands from students, faculty, and staff (Jeong et al., 2020). To assess the quality of sustainability offerings at the partner universities and address some of the identified gaps in research, this study aims to:

1. Determine the sustainability awareness level of students and staff by evaluating knowledge and familiarity, attitudes and behavioural practices related to sustainability
2. Facilitate the optimisation of efforts at the partner universities aimed at improving the standards, performance, offerings, and ethos related to sustainable education

The study will also test the hypothesis that higher educational levels lead to increased sustainability awareness, more positive attitudes, and improved behavioural practices.

4 Results

The results of the case studies review and the survey results are described below.

4.1 Case Studies

Metropolia University of Applied Sciences is a Finnish higher education institution with 17,400 students and 1040 staff members, consisting of four campuses. The Myllypuro Campus, the university's largest campus, was selected for this study. The campus was finished in 2019 and has around 8000 registered students and 500 staff members. The campus houses the School of Healthcare and Wellbeing and the School of Real Estate and Construction.

The Baden-Wuerttemberg Cooperative State University (Duale Hochschule Baden-Württemberg/DHBW) was founded in 2009 and is located in different cities of Baden-Wuerttemberg in Germany. The DHBW Stuttgart Campus consists of three faculties (Management & Economics, Engineering and Social Work) and has around 7600 enrolled students and 460 full-time employees. The technical faculty of DHBW Stuttgart, with approx.100 full-time employees (FTEs) and 1790 enrolled students, was used as the case study.

The Polytechnic of Leiria (IPL) is a Portuguese higher education institution located in the western region of Portugal. It has five faculties and accommodates 13,000 registered students and 1,600 employees.

Finally, the Polytechnic University of Hauts-de-France (Université Polytechnique Hauts-de-France: UPHF) is a French higher education institution in Valenciennes. It was established in 1964, and its Le Mont Houy Campus accommodates around 11000 registered students and over 1200 full-time employees.

4.2 Survey Results

4.2.1 Profile of Participants

Out of 855 participants from the four campuses, DHBW-Stuttgart had the highest representation, comprising 37% of the total participants with 318 respondents, followed by Metropolia with 27% (219 participants). IPL and UPHF accounted for 20% (168 participants) and 18% (150 participants) respectively.

714 completed the entire survey. The number of completed surveys per campus, therefore, also varied slightly. The numbers were as follows: DHBW: 264, IPL: 128, Metropolia: 181, and UPHF: 141 (see Figure 7 for a visual representation). These figures indicate a satisfactory distribution of participants among the partner universities.

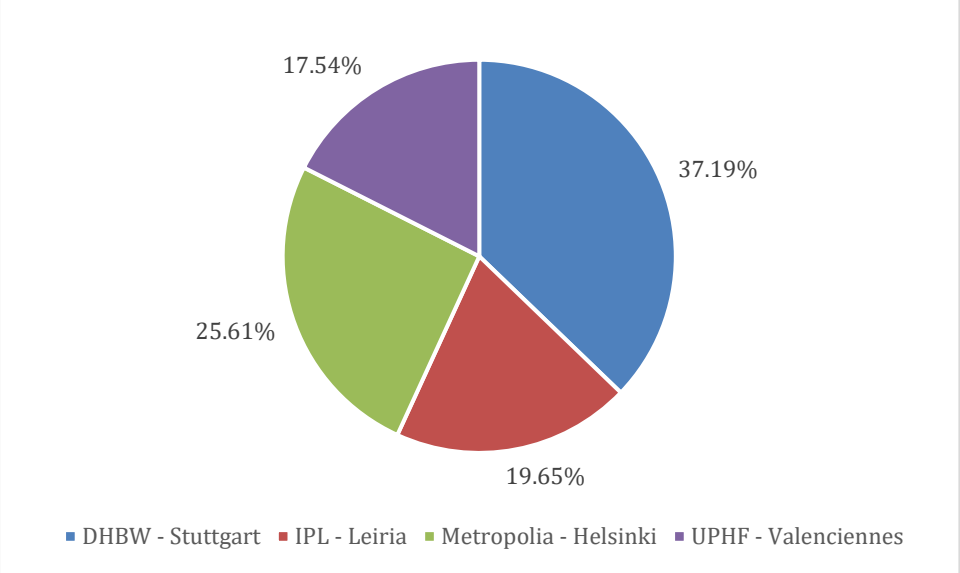

Figure 7: Percentage of Participants Per Campus

The survey predominantly comprised students, accounting for 84% (717) of the total participants, while staff (lecturers and administration) constituted 15% (127) of the respondents (refer to Figure 8 and Table 1 for a detailed breakdown). Regarding survey completion, 617 students and, 90 lecturers and administrative personnel completed the entire survey. This yields a ratio of 7 students to every staff member: a good representation of the engineering departments of each university.

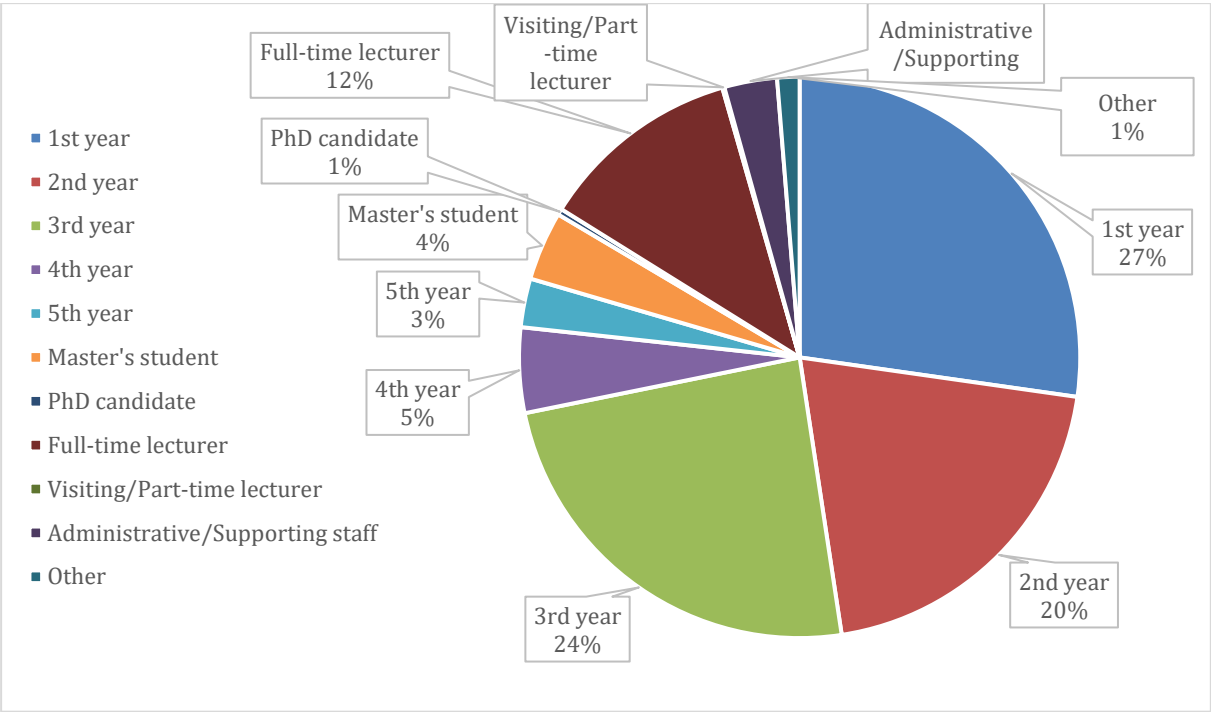

Figure 8: Profile of Participants

	DHBW - Stuttgart	IPL - Leiria	Metropolia - Helsinki	UPHF - Valenciennes	Total
1st year	107	26	39	61	233
2nd year	42	36	63	33	174
3rd year	100	44	52	11	207
4th year	5	4	14	19	42
5th year	16	2	2	4	24
Master's student	1	13	17	3	34
PhD candidate	3	0	0	0	3
Total no. of Students	274	125	187	131	717
Full-time lecturer	25	35	24	16	100
Visiting/Part-time lecturer	0	1	0	0	1
Administrative/ Supporting staff	13	3	7	3	26
Total no. of Lecturers/Staff	38	39	31	19	127
Other	6	4	1	0	11
Total	318	168	219	150	855

Table 1: Profile of Participants Per Campus

4.2.2 Education and Experience Related to Sustainability

4.2.2.1 Skill Set of Staff and Students

As depicted in Table 2, nearly 67% of the staff across the four universities reported having experience with sustainability-related projects or teaching sustainability concepts. Notably, the Metropolia campus stood out, with 84% of its staff possessing such experience.

		I have experience working on sustainability-related projects/initiatives or teaching sustainability concepts.		
		Yes	No	**Total**
Please choose your university.	DHBW - Stuttgart	5 (29%)	12	17
	IPL - Leiria	18 (78%)	5	23
	Metropolia - Helsinki	16 (84%)	3	19
	UPHF - Valenciennes	9 (69%)	4	13
	Total	48 (67%)	24	72

Table 2: The Number of Lecturers and Administrative Staff with Experience in Sustainability-Related Projects and Teaching

Table 3 illustrates that environmental training (20%) and science/technology (43%) were the most prevalent specialisations among staff. This distribution aligns with the survey's broader dissemination within the engineering departments.

		In what areas do you have experience teaching or working on sustainability-related projects/initiatives/activities? Please select all that apply.									
		Economic	Social	Environmental	Individual/ Community wellbeing	Governance/ Citizen participation	Philosophical/ Ethical	Science/ Technology	Oth	No experience	Total
	DHBW - Stuttgart	6	0	2	0	1	0	9	1	4	23
	IPL - Leiria	2	2	10	0	1	0	19	0	3	37
	Metropolia - Helsinki	0	3	5	3	0	3	14	1	2	31
	UPHF - Valenciennes	0	1	5	0	1	2	4	0	4	17
	Total	8	6	22	3	3	5	46	2	13	108

Table 3: Areas of Specialisation of Lecturers and Administrative Staff

Approximately one-third of the staff believed that students possessed sufficient skills to meet the sustainability requirements of the job market, as indicated in Figure 9. A

noteworthy observation is that most respondents opted for a neutral stance, refraining from expressing either a positive or negative opinion. Detailed figures for each campus are found in Table 4. The IPL campus provided the most favorable assessment of students' skillset, with approximately 52% expressing confidence in their students' abilities.

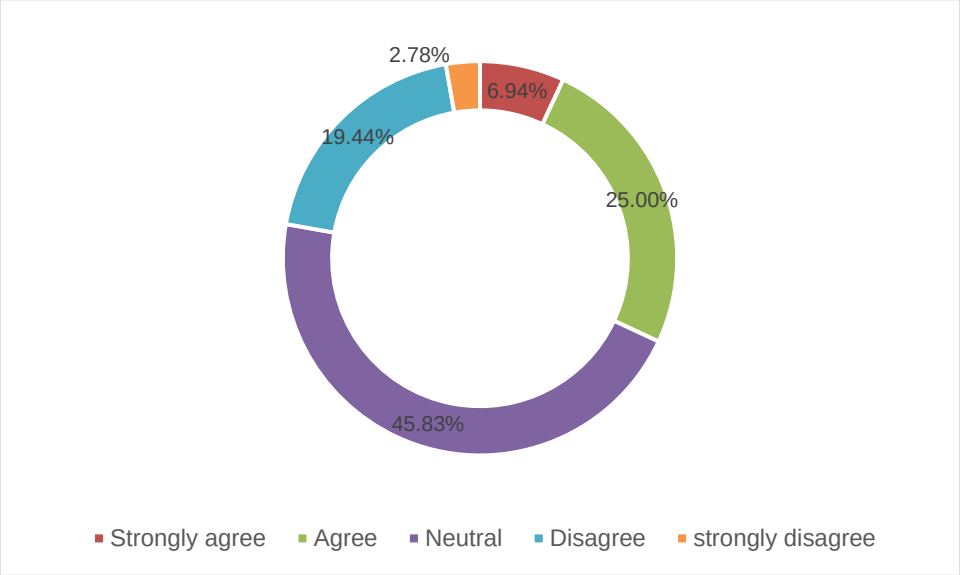

Figure 9: Perspectives of Staff on The Sustainability Skill Level of Students

		My students have adequate skills to meet the sustainability demands of the job market.					
		Strongly agree	Agree	Neutral	Disagree	Strongly disagree	**Total**
Please choose your university.	DHBW - Stuttgart	0	3	10	4	0	17
	IPL - Leiria	2	10	7	4	0	23
	Metropolia - Helsinki	2	4	11	1	1	19
	UPHF - Valenciennes	1	1	5	5	1	13
	Total	5	18	33	14	2	72

Table 4: Staff's Views on the Sustainability Skill Level of Students

There was a notable lack of familiarity with sustainability competences frameworks (SCFs) among staff, as more than 60% reported not knowing these frameworks (see Figure 10). The greatest familiarity was expressed by IPL; approximately half of the IPL participants confirmed familiarity with SCFs (see Table 5). In the follow-up question, participants were required to provide examples of SCFs. The responses,

which range from GRI to sustainable development goals, confirmed that few participants had adequate knowledge of the topic.

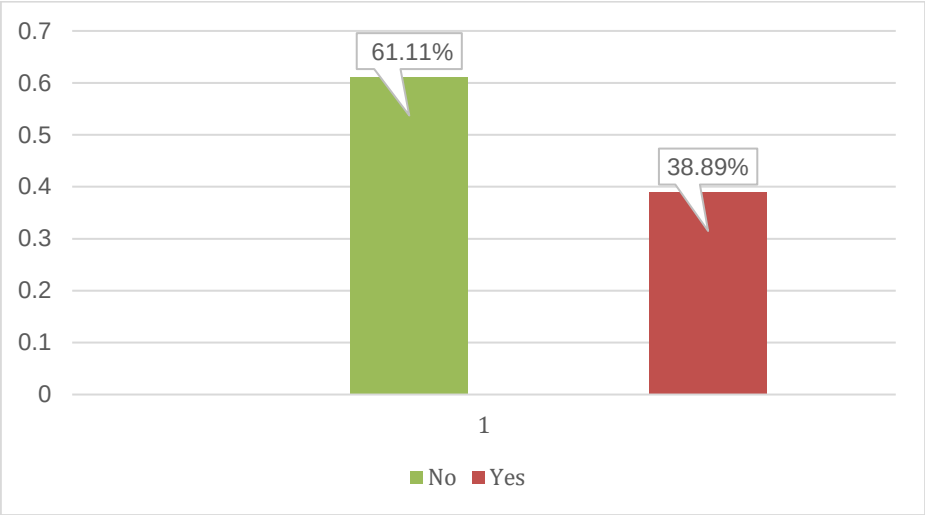

Figure 10: Staff's Familiarity with Sustainability Competences Framework

		I am familiar with the Sustainability Competences Frameworks.		
		Yes	No	**Total**
Please choose your university.	DHBW - Stuttgart	6 (35%)	11	17
	IPL - Leiria	12 (52%)	11	23
	Metropolia - Helsinki	6 (32%)	13	19
	UPHF - Valenciennes	4 (31%)	9	13
	Total	28 (39%)	44	72

Table 5: Staff's Familiarity with Sustainability Competences Framework by Campus

When asked to select relevant curriculum entry points into sustainability, the staff identified resource management as the most favourable topic (14%), followed by pollution control/cleaner production (13%) (refer to Figure 11).

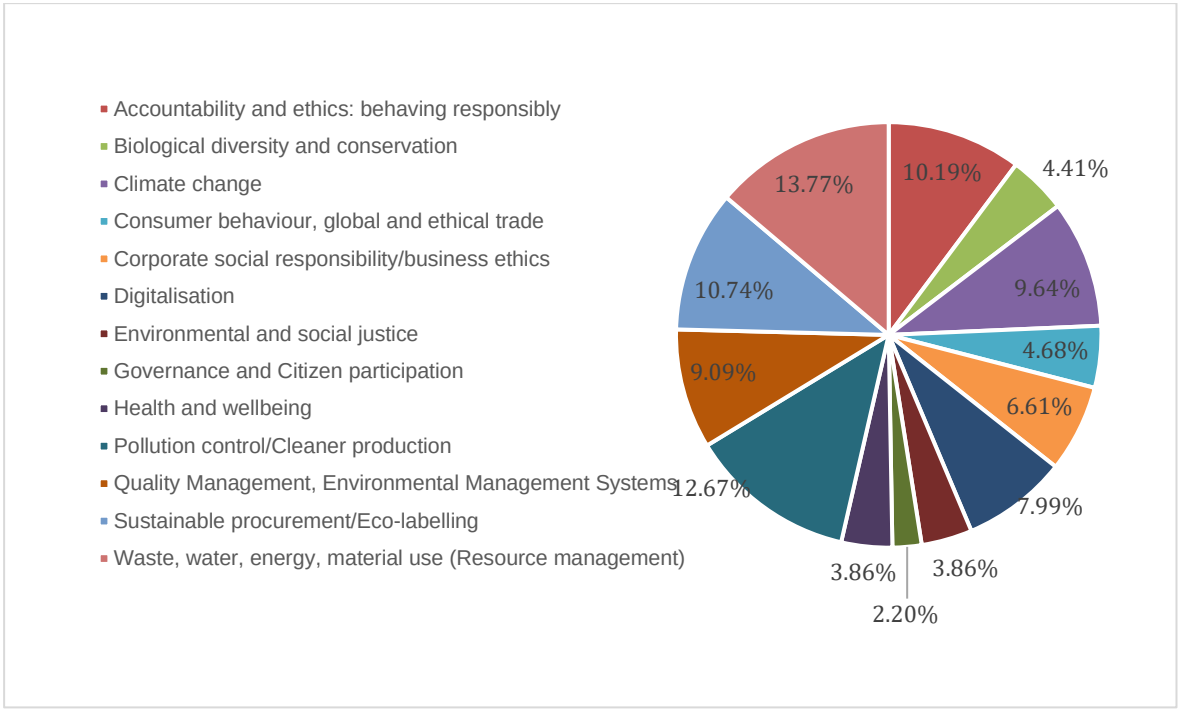

Figure 11: Relevant Topics as a Curriculum Entry Points into Sustainability

All participants were asked to rate their level of academic training related to sustainability and sustainable development topics. The results, as seen in Figure 12, confirmed that respondents gave a moderate assessment, with close to 51% confirming that either they were extensively or adequately trained.

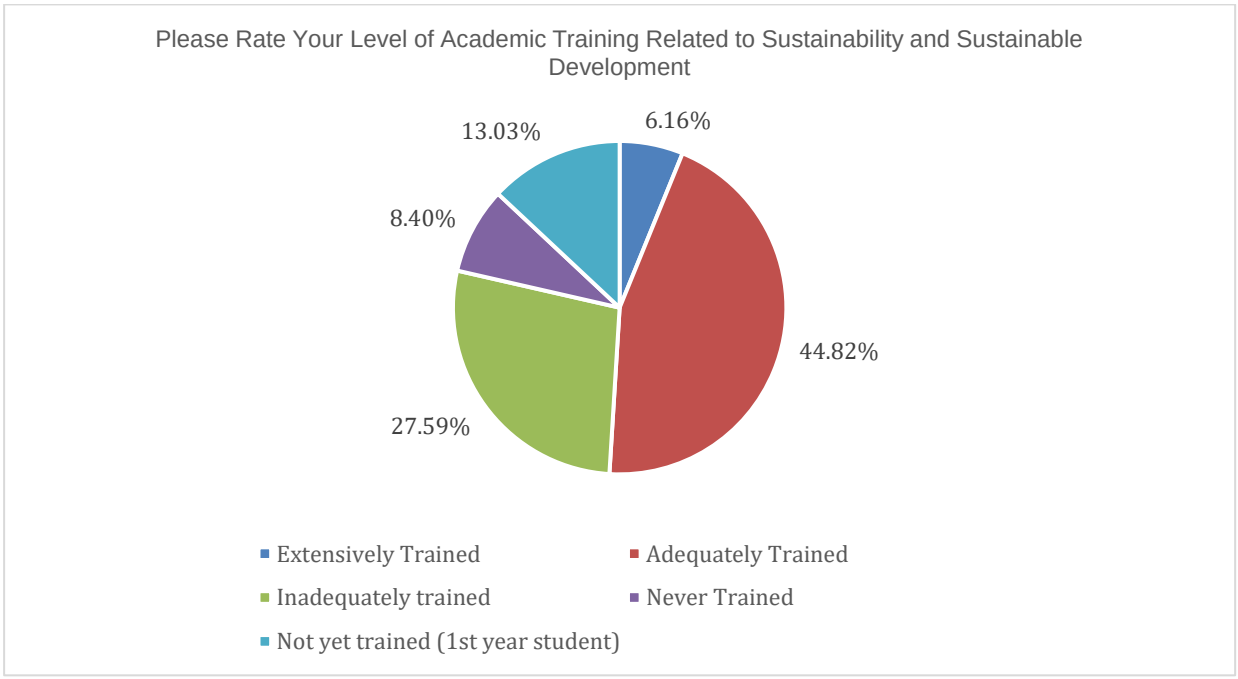

Figure 12: Participants' Rating of Their Level of Academic Training Related to Sustainability and Sustainable Development

A detailed examination of the responses per campus (refer to Table 6) revealed that half of the respondents across three campuses (DHBW, IPL, UPHF) believed they were extensively or adequately trained. Conversely, there was a slightly higher confidence level at Metropolia, with close to 60% of participants expressing a positive view of their training level.

		Please rate your level of academic training related to sustainability and sustainable development topics.						
		Extensively Trained	Adequately Trained		Inadequately trained	Never Trained	Not yet trained (1st year student)	**Total**
Please choose your university.	DHBW - Stuttgart	26	97	47 %	69	31	41	264
	IPL - Leiria	6	57	49 %	41	8	16	128
	Metropolia - Helsinki	6	101	59 %	51	7	16	181
	UPHF – Valenciennes	6	65	50 %	36	14	20	141
	Total	44	320	51 %	197	60	93	714

Table 6: Participants' Rating of Their Level of Academic Training Related to Sustainability and Sustainable Development Per Campus

Reviewing the training rates based on participants' backgrounds (see Table 7), 50% of both students and staff believed their academic training level was either extensive or adequate.

		Please rate your level of academic training related to sustainability and sustainable development topics.						
		Extensively Trained	Adequately Trained		Inadequately trained	Never Trained	Not yet trained (1st year student)	**Total**
Please select your current standing.	1st year	9	73	41%	19	8	91	200
	2nd year	6	70	51%	60	12	0	148
	3rd year	15	95	60%	58	14	2	184
	4th year	1	12	35%	19	5	0	37
	5th year	4	8	71%	5	0	0	17
	Master's student	3	16	66%	7	3	0	29
	PhD candidate	0	1	50%	0	1	0	2
	Total no. of students	38	275	51%	168	43	93	617
	Full-time lecturer	3	37		18	11	0	69
	Visiting/Part-time lecturer	1	0		0	0	0	1
	Administrative/Supporting staff	1	4		10	5	0	20
	Total no. of Staff Members	5	41	51%	28	16	0	90
	Other	1	4		1	1	0	7
	Total	44	320	51%	197	60	93	714

Table 7: Participants' Rating of Their Level of Academic Training Related to Sustainability and Sustainable Development According to Background of Participants

4.2.2.2 Awareness of Key Sustainability Concepts

Participants were tasked with reporting their familiarity with crucial sustainability concepts. The findings, depicted in Figure 13, revealed that 40% of participants believed that they were either extremely familiar or familiar with sustainability concepts. To gauge this awareness, participants were asked to rate their familiarity with three core elements of sustainability/sustainable development, sustainable development goals, and the greenhouse gas effect.

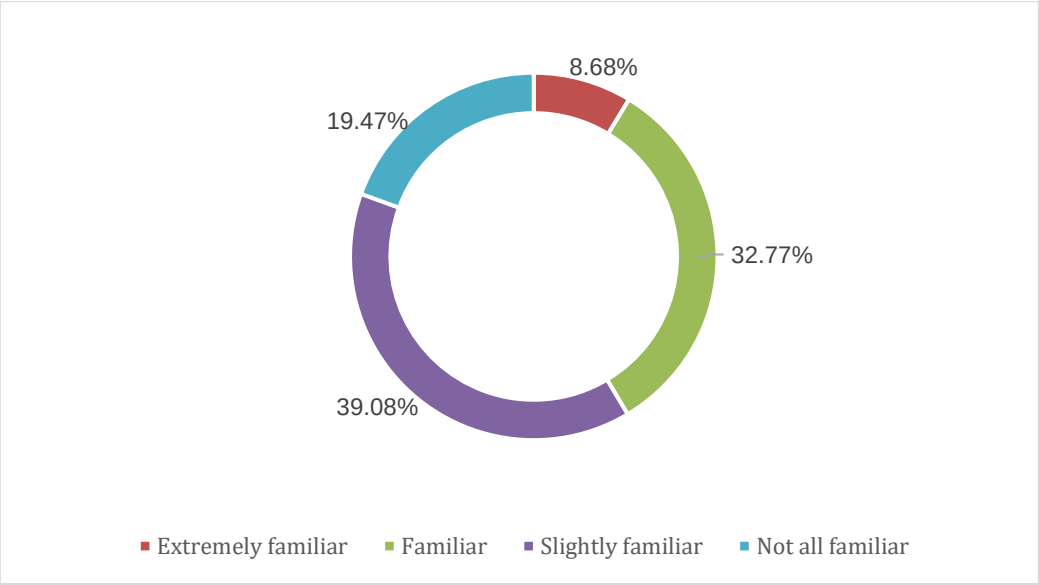

Figure 13: Participants' Level of Familiarity with Key Concepts Related to Sustainability and Climate Change

As demonstrated in Table 8, respondents were most familiar with the greenhouse gas effect, with over 80% confirming being extremely familiar or familiar with the concept, compared to 64% with SDGS and 41% with the three core sustainability elements.

Statement	Extremely familiar	Familiar	Slightly familiar	Not all familiar	Overall
The three core elements of Sustainability/Sustainable Development	62	234	279	139	714
	8.68%	32.77%	39.08%	19.47%	100.00 %
Sustainable Development Goals	78	385	212	39	714
	10.92%	53.92%	29.69%	5.46%	100.00 %
Greenhouse Gas Effect	218	380	106	10	714
	30.53%	53.22%	14.85%	1.40%	100.00 %

Table 8: Participants' Level of Familiarity with Sustainability and Sustainable Development Topics

A deeper look at the results per campus demonstrated that IPL was most familiar with the three concepts of sustainable development/sustainability (54%), UPHF was most familiar with SDGs (77%), and Metropolia was most familiar with the greenhouse gas effect (86%). The figures for the respective campuses are included in Table 9.

		Three core elements of sustainability/SD		Sustainable Development Goals		Greenhouse Gas Effect	
		Fam.	Unfam.	Fam.	Unfam.	Fam.	Unfam.
Please choose your university.	DHBW – Stuttgart Total no. of participants: 264	33% (87)	30% (78)	53% (140)	9% (24)	85% (225)	1% (3)
	IPL – Leiria Total no. of participants: 128	54% (69)	13% (16)	61% (78)	5% (7)	82% (105)	0.7% (1)
	Metropolia – Helsinki Total no. of participants: 181	37% (67)	20% (25)	75% (136)	1% (2)	86% (156)	0%
	UPHF – Valenciennes Total no. of participants: 141	52% (73)	14% (20)	77% (109)	4% (6)	79% (112)	4% (6)

Table 9: Participants' Level of Familiarity with Sustainability/Sustainable Development Concepts per Campus

When comparing students' and staff's responses (Table 10), both students and staff were most familiar with the greenhouse gas effect and least familiar with the three core elements of sustainability/sustainable development.

		Three Core Elements of Sustainability/Sustainable Development		Sustainable Development Goals		Greenhouse Gas Effect	
		Familiar	Unfamiliar	Familiar	Unfamiliar	Familiar	Unfamiliar
Please select your current standing.	Students Total no. of participants: 617	245 (40%)	123 (20%)	396 (64%)	35 (6%)	516 (84%)	9 (1%)
	Staff (Lecturers and Administration) Total no. of participants: 90	46 (51%)	15 (17%)	61 (68%)	4 (4%)	75 (83%)	1 (1%)

Table 10: Familiarity of Staff and Students with Sustainability/Sustainable Development Concepts

4.2.2.3 Knowledge related to Climate Change

To test participants' knowledge about climate change, respondents were required to answer questions relating to the causes and consequences of climate change. The results demonstrated that respondents have a good general understanding of factors contributing to climate change, as most participants correctly identified agriculture, forest fires, and volcanic eruptions as activities that lead to climate change. However, nearly 80% of respondents mistakenly believed that water pollution contributes to climate change, while 33% perceived climate change as a natural part of the climate cycle (see Figure 14).

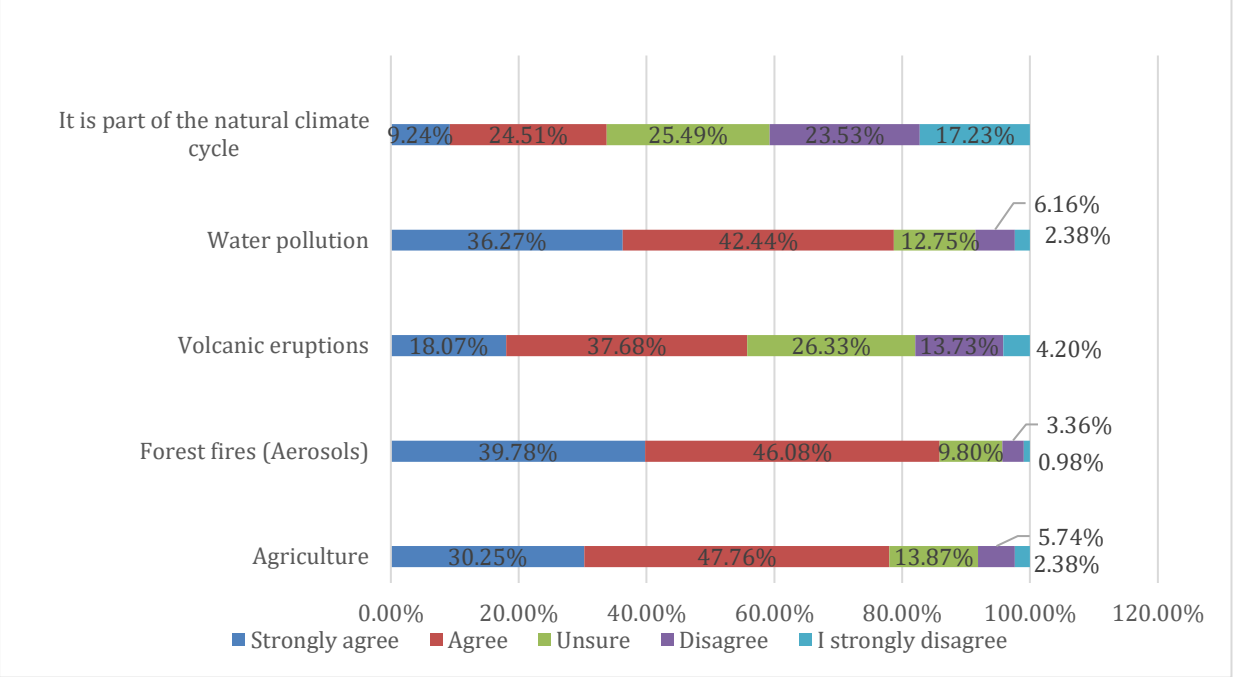

Figure 14: Participants' Assessment of Factors that Contribute to Climate Change

In the revision of responses by campus, agriculture was recognised by over 65% of the participants for each campus (the most: DHBW-85%, the least: IPL-66%). Forest fires were widely recognised by all campuses (>85%). There appears to be a lack of understanding regarding the relationship between climate change and volcanic eruptions, with as low as 48% of participants (IPL) and as high as 63% (Metropolia) believing this factor contributes to climate change.

There was even less understanding of the impact of water pollution, with over 70% of participants across all campuses incorrectly identifying it as a contributor to climate

change. When considering whether climate change is part of the natural cycle of climate change, the most significant number of participants who agreed came from IPL (47%), and the largest number who did not agree or were unsure was DHBW (73%).

The responses provided by students and staff showed that the differences were not significant, except for agriculture, with 76% of students and 90% of staff identifying this activity as a contributing factor to climate change.

	Background of Participants					
Cause of Climate Change	DHBW (Total: 264)	IPL (Total: 128)	Metropolia (Total: 181)	UPHF (141)	Student (617)	Staff (90)
Agriculture	84%	66%	86%	67%	76%	90%
Forest Fires	86%	88%	85%	86%	85%	88%
Volcanic Eruptions	53%	60%	63%	48%	56%	57%
Water Pollution	72%	88%	81%	81%	78%	80%
Part of the natural climate cycle	27%	47%	34%	34%	34%	33%

Table 11: Participants' Assessment of Factors that Contribute to Climate Change per Background of Participants

In assessing the knowledge of the impacts of climate change, the responses suggest a sound understanding of the consequences of climate change. Approximately 65% recognised ocean acidification as a consequence of climate change, more than 80% identified the increase in displaced people/refugees as another consequence, and over 90% believed that climate change resulted in the increased occurrence of droughts. However, 31% either agreed or were unsure whether climate change leads to decreased sea levels, and 12% believed climate change results in increased biodiversity. The feedback of participants on the impacts of climate change is provided in Figure 15.

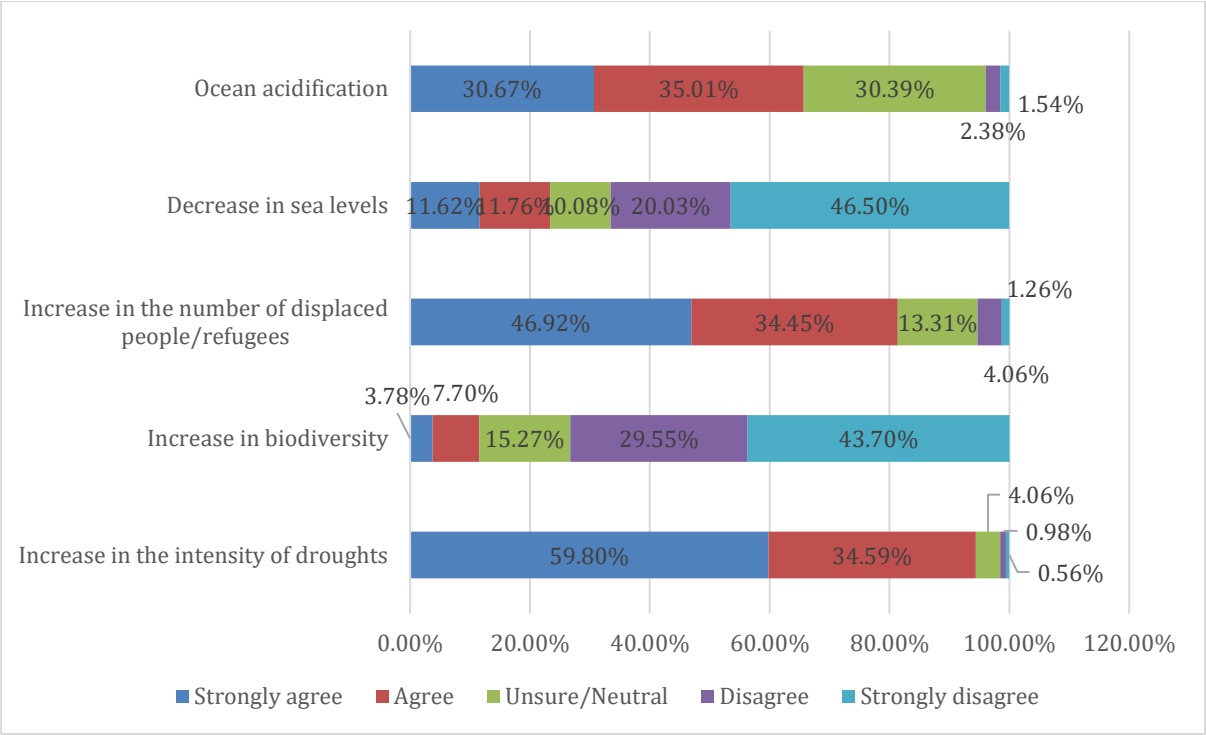

Figure 15: Participants' Assessment of the Consequences of Climate Change

Considering the backgrounds of participants, it was evident that an overwhelming majority across all campuses had adequate knowledge about the consequences of climate change (see Table 12). Participants were less certain about climate change as a contributing factor to ocean acidification, with fewer identifying this process as a consequence of climate change. Responses from students and staff showed minimal differences, except in the assessment of 'Increase in Biodiversity.' Notably, 20% of staff incorrectly believed that climate change leads to an increase in biodiversity, compared to only 2% of students.

	Background of Participants					
Consequences of Climate Change	DHBW (Total: 264)	IPL (Total: 128)	Metropolia (Total: 181)	UPHF (141)	Student (617)	Staff (90)
Increase in the intensity of droughts	96%	98%	91%	93%	95%	93%
Increase in Biodiversity	8%	11%	13%	17%	13%	2%
Increase in the number of displaced persons/refugees	85%	79%	85%	73%	80%	88%
Decrease in sea levels	18%	29%	19%	33%	24%	19%
Ocean acidification	65%	78%	56%	69%	65%	71%

Table 12: Participants' Assessment of Factors Responsible for Climate Change per Background of Participants

4.2.3 Attitudes Related to Climate Change and Sustainability

To assess participants' perceptions and views on climate change and sustainability topics, several assertions were proposed, and participants were asked to rate these statements: Climate change is a significant concern to me; I have been affected by the effects of climate change; Climate change is too complex to be easily addressed; The current rate of climate change is mostly attributed to human activities; The topic of climate change is NOT as important as social and economic issues, and Climate change presents a threat to both present and future generations.

76% of participants saw climate change as a significant concern, even though only half of the respondents had been affected by climate change. There was cautious optimism about combating or addressing climate change, with 46% seeing the topic as too complex to be easily addressed.

According to 86% of respondents, the current rate of climate change is primarily attributed to human activities, which directly contradicts sentiments expressed by 33% of participants who believed that climate change is part of the natural climactic cycle.

Nearly 90% of participants saw climate change as important as social and economic issues. This is in line with most participants (89%) seeing climate change as a threat

to both present and future generations. Figure 16 demonstrates the responses from the survey's respondents.

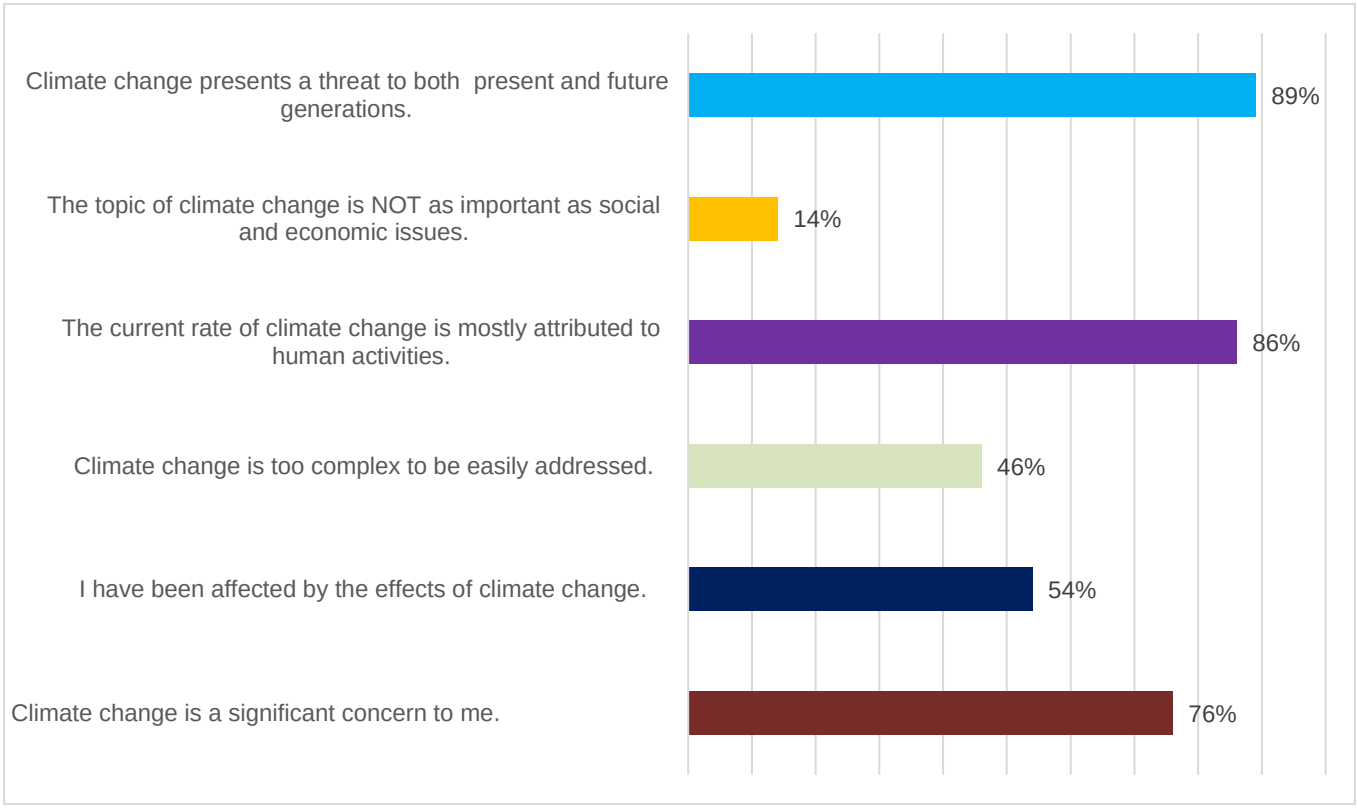

Figure 16: Feedback on Assertions relating to Climate Change

When analysing participants' beliefs, concerns, and values based on their backgrounds, there were few significant findings. The most significant was that climate change was the greatest concern for IPL respondents (87%) and staff (91%) (see Table 13).

	Background of Participants					
Assertions	DHBW	IPL	Metropolia	UPHF	Student	Staff
Climate change is a significant concern to me.	76%	87%	69%	76%	74%	91%
I have been affected by the effects of climate change.	63%	43%	57%	43%	52%	66%
Climate change is too complex to be easily addressed.	54%	47%	29%	45%	44%	44%
The current rate of climate change is mostly attributed to human activities.	90%	88%	83%	80%	85%	94%
Climate change is NOT as important as social and economic issues.	14%	9%	14%	16%	15%	7%
Climate change presents a threat to both present and future generations.	93%	91%	83%	83%	63%	72%

Table 13: Feedback on Assertions Relating to Climate Change

4.2.4 Behavourial Practices Related to Climate Change and Sustainability

Participants were asked to assess their commitment to sustainability practices by evaluating the following statements: I actively participate in climate action and sustainable practices; I would change my behaviour, but at present, I do not know what to do; I would change my behaviour, but it is too time-consuming, costly, difficult, etc.; I feel that industries and governments are more responsible than the actions of individuals in the fight against climate change; and I feel my university supports me in acting more sustainably.

Only 47% of participants confirmed that they actively participate in climate action and sustainable practices. Interestingly, 32% of participants expressed uncertainty or neutrality when it comes to participating in sustainable practices. This number aligns closely with the percentage of participants who stated that they did not have adequate knowledge on how to change their behaviour (29%) or were unsure/neutral about having the required knowledge (32%) to behave sustainably. When considering if participants were limited by other factors, 32% expressed that they were limited by time, cost, or ease of implementation, whereas 40% expressed the opposite.

Participants also recognised the role of governments and industries in climate action, with 2/3 of respondents citing that these groups have more substantial influence than individual action in addressing the climate change issue.

Likewise, participants felt their universities could do a better job supporting more sustainable behaviour. Only 39% of participants affirmed that their universities were doing a satisfactory job. Figure 17 demonstrates the responses from the survey's respondents.

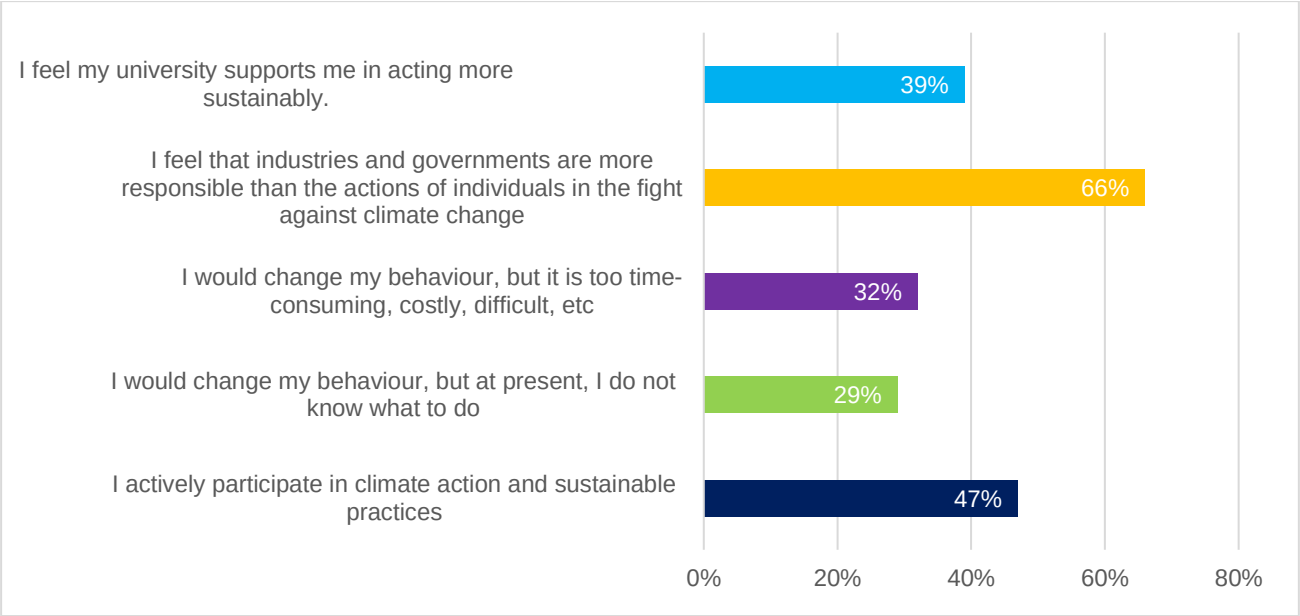

Figure 17: Feedback on Assertions Related to Sustainable Behaviour

When assessing these assertions against the participants' backgrounds, there were no significant revelations with one exception. Most participants from all campuses opined that they had adequate knowledge to change their behaviour. The campus with the most participants reporting that they would change their behaviour but did not know what to do was UPHF (45%).

When comparing students and staff, the most significant observation was that staff were more active than students in climate action and sustainable practices (66%: 43%). Both students and staff expressed dissatisfaction with the sustainability offerings at their universities, with 44% of staff and 38% of students stating that they felt that their universities supported them in acting more sustainably.

Background of Participants						
Assertions	DBHW	IPL	Metropolia	UPHF	Student	Staff
I actively participate in climate action and sustainable practices	41%	54%	49%	49%	43%	66%
I would change my behaviour, but at present, I do not know what to do.	22%	37%	20%	45%	30%	19%
I would change my behaviour, but it is too time-consuming, costly, difficult, etc.	34%	26%	28%	38%	34%	19%
I feel that industries and governments are more responsible than the actions of individuals in the fight against climate change.	69%	58%	71%	60%	68%	51%
I feel my university supports me in acting more sustainably.	30%	51%	47%	34%	38%	44%

Table 14: Feedback on Assertions relating to Sustainability According to the Background of Participants

4.2.5 Relationship between Sustainable Education and Awareness, Attitude and Behavourial Practices Among Students

To determine if education impacts students' awareness, attitudes, and behavioural practices, the student's educational level was compared to their views on their level of training and familiarity, attitude, and behaviour related to sustainability and climate change themes.

First-, second- and third-year students were selected as the focus group because they comprised the majority of participants, and the bachelor's degree program at several partner universities spans three years.

Figure 18 demonstrates that as the students' education level increases, so does the satisfaction rate with their sustainability training. There was a 10% increase from year 1 to year 2 and a 9% increase from year 2 to year 3.

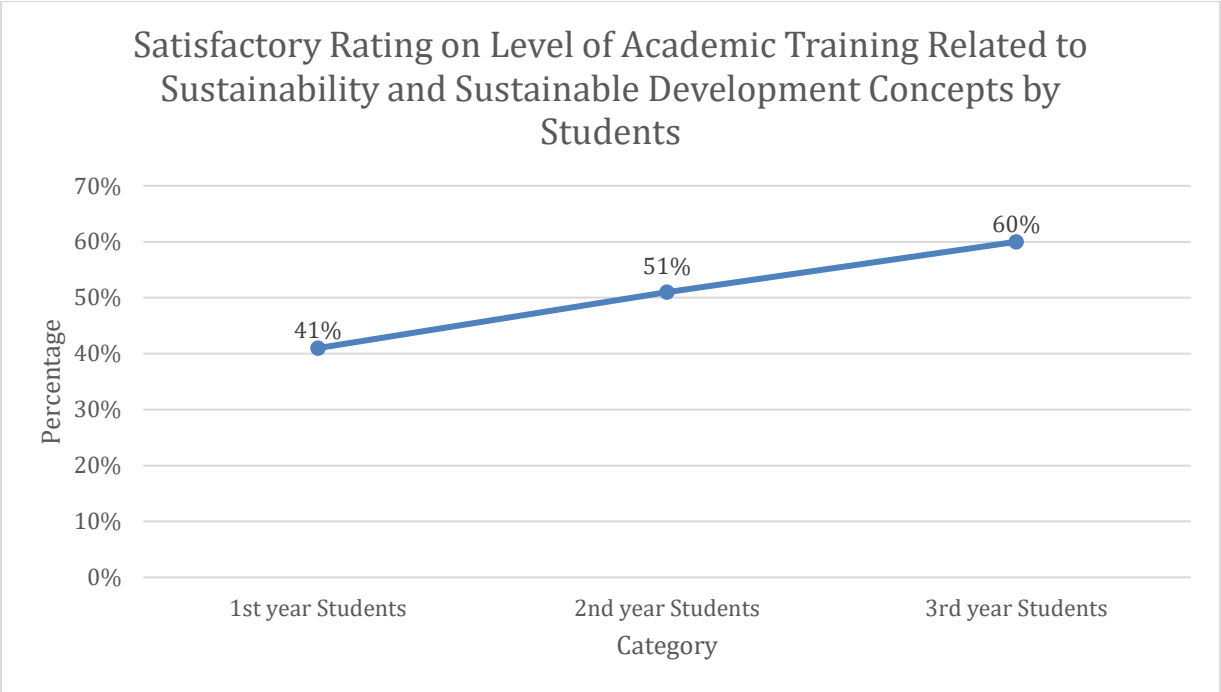

Figure 18: Satisfactory Rating on Level of Academic Training Related to Sustainability and Sustainable Development Topics by Students

Figure 19 aims to demonstrate whether a relationship exists between education and awareness levels for the focus group. The data show that all categories are very familiar with the greenhouse gas effect and relatively familiar with the SDGs. The three core elements of sustainability were the least familiar concept, with second-year students demonstrating the least familiarity. The data confirms that that there is no correlation between education and awareness level for the students, as familiarity with sustainability concepts did not increase with students' educational level.

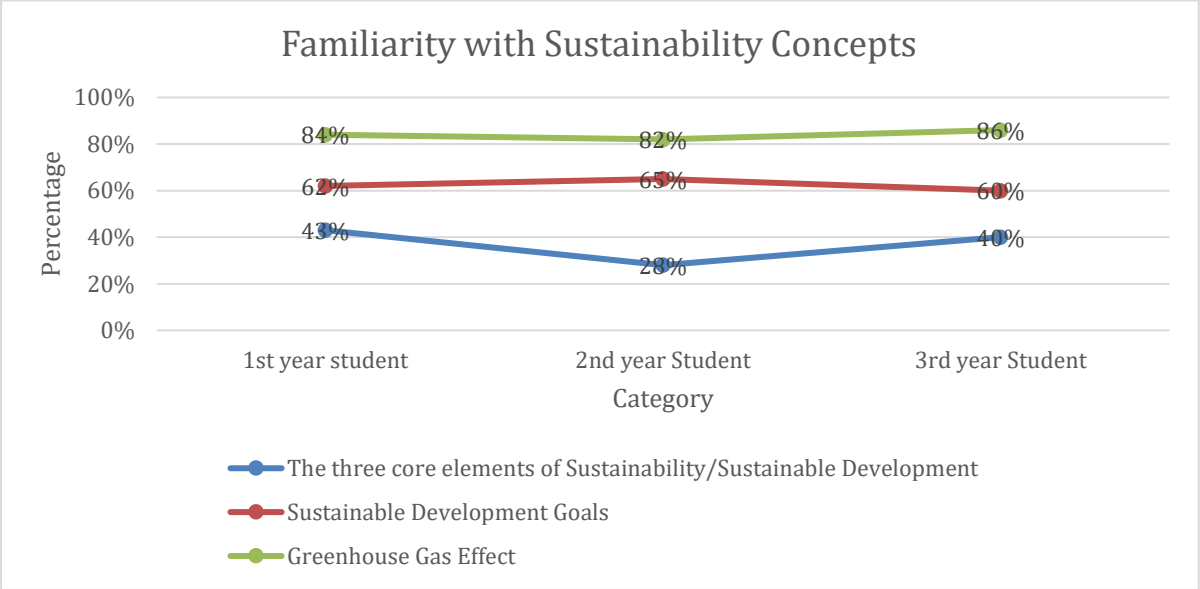

Figure 19: Familiarity with Sustainability Concepts among 1st, 2nd, and 3rd-year Students

Figure 20 aims to illustrate whether a relationship exists between educational training and pro-sustainability attitude for the different categories of students. The numbers indicate that all categories largely believed: 'the current rate of climate change is largely attributed to human activities' and 'the topic of climate change is as important as social and economic issues.'

The percentage of students who reported being affected by climate change or saw climate change as being too complex to be easily addressed remained relatively the same from year 1 to year 3.

A noteworthy observation is that the agreement with the assertions 'climate change is a significant concern to me' and 'the topic of climate change is as important as social and economic issues' increased from the first to the second year.

It is, therefore, hard to conclusively state if increasing educational level leads to pro-sustainability attitudes

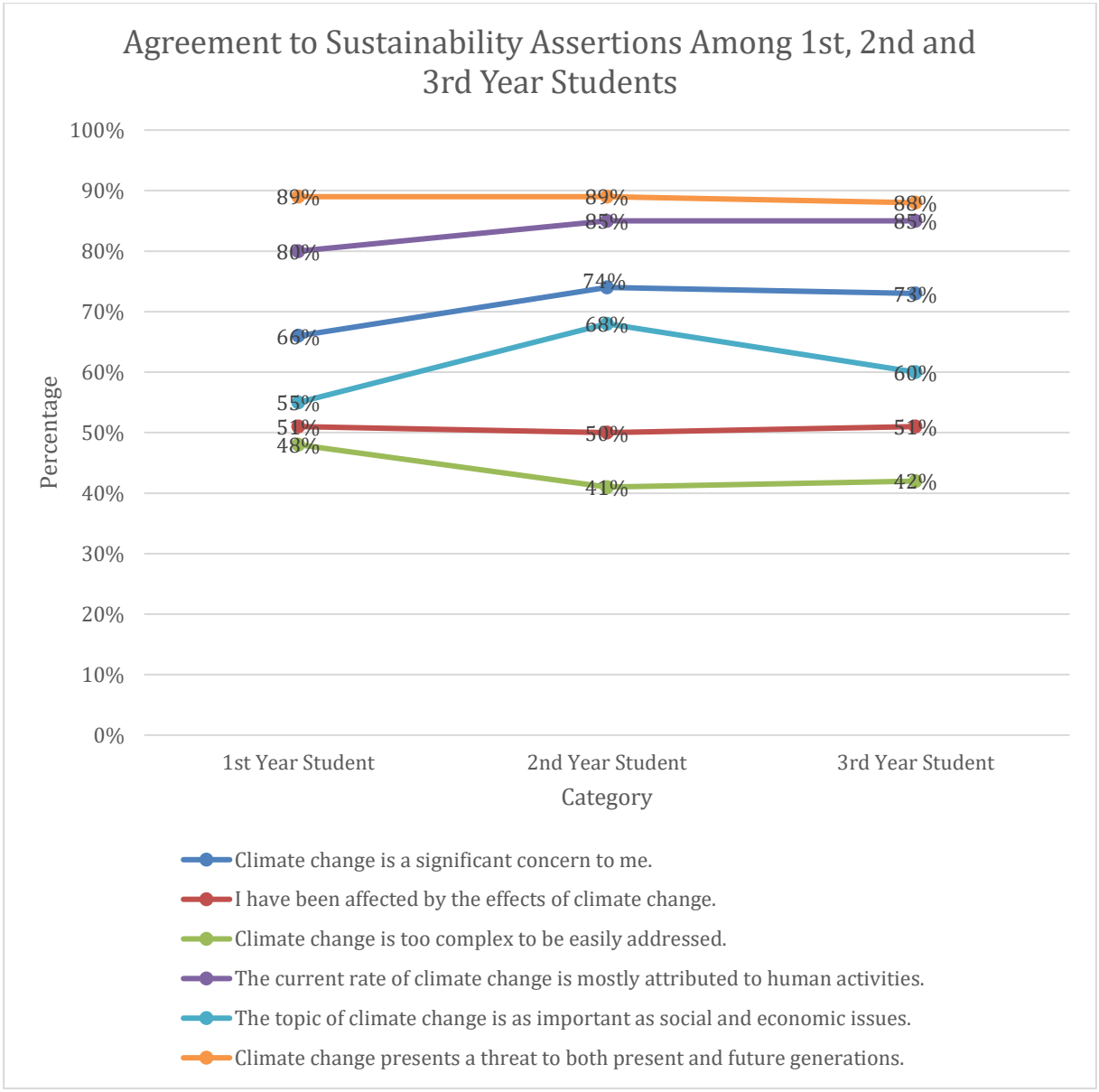

Figure 20: Agreement Towards Sustainability Assertions among 1st, 2nd, and 3rd-year Students

Figure 21 aims to illustrate whether a correlation exists between educational level and sustainable behaviour for the selected groups of students. Students from all categories (Year 1: 68%; Year 2: 67% and Year 3: 68%) largely recognised the role of industries and governments in the fight against climate change. However, all groups barely recognised the role of individual action, with low numbers reporting to behave sustainably or taking part in climate action. The most active group was Year 2, with 45%. The majority of students did not identify limiting factors such as knowledge, cost, time, or ease of implementation (from Year 1 to Year 3) to explain their lack of personal involvement.

A key observation was the negative correlation between educational level and the belief that universities support sustainable behavioural practices.

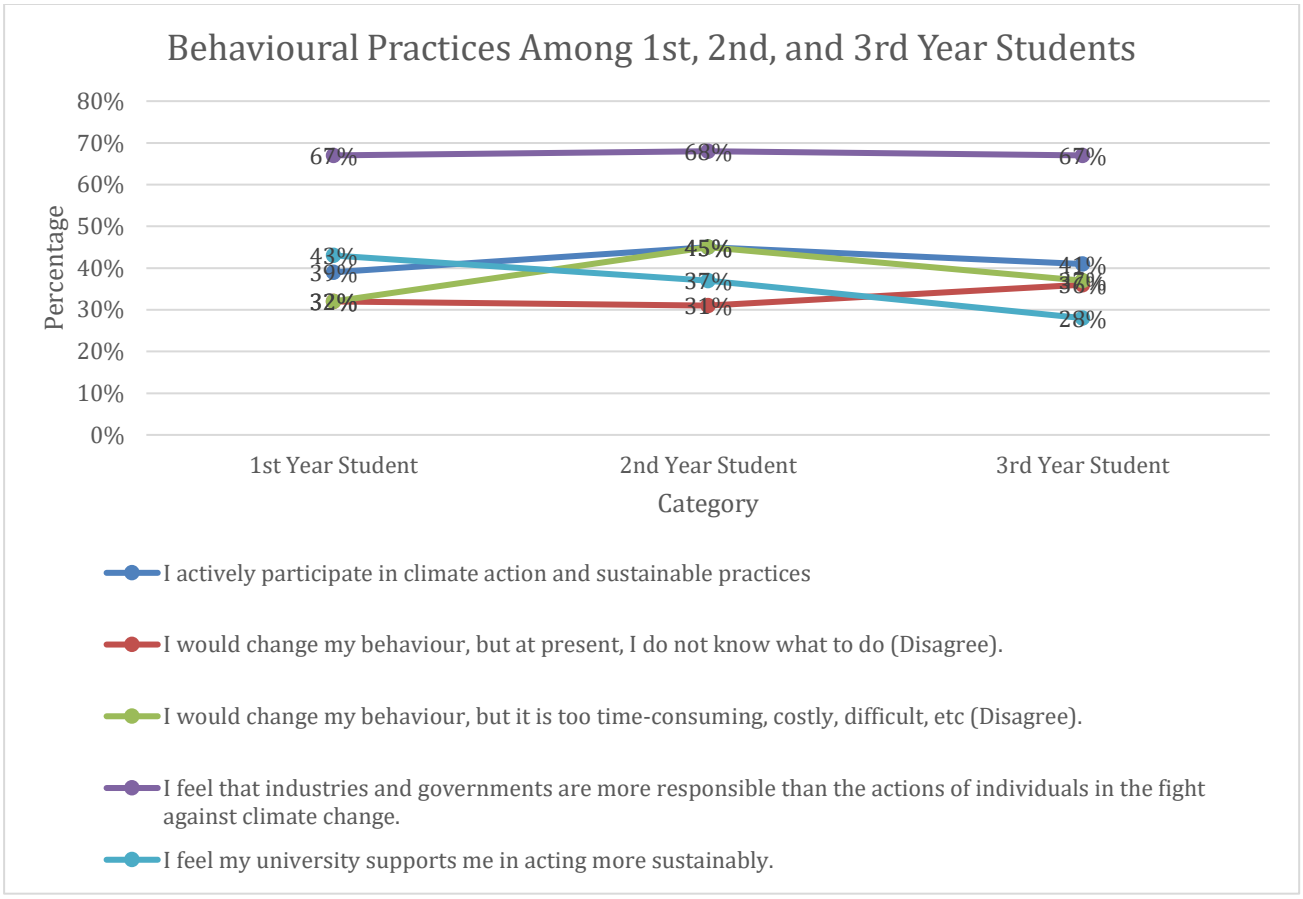

Figure 21: Behavioural Practices Among 1st,2nd, and 3rd-Year Students

5 Discussion and Recommendation

This survey revealed participants' sustainability awareness level by assessing their knowledge and familiarity with key sustainability concepts, attitudes and behavioural practices. It also provided views on the quality of sustainability teaching offered at individual campuses and provided results on the proposed hypothesis that increasing education levels affect students' awareness, attitudes, and behavioural practices. The results are discussed in this chapter.

5.1 Demographics of Participants

The survey results were predominantly influenced by the views of students, as they constituted over 80% of the participants. Staff members (lecturers and administration) were, therefore, markedly underrepresented. This disparity may be due to the perception that the survey's objectives were primarily focused on students' needs. As the willingness of leaders, policymakers, decision-makers, and other administrative staff within the university community is often missing, it has slowed and resulted in failed attempts at the sustainable transition of educational institutions (Avila et al., 2017). The underrepresentation of staff highlights the need to actively engage and motivate these university members if a community in which sustainability is not just a word but a way of being.

Recommendation 1: Explore innovative training activities, e.g. serious games, and promote lifelong learning opportunities to motivate and regularly train the university's staff members so as to increase interest and involvement in sustainability initiatives.

5.2 Sustainable Education and Awareness

The quality of the teaching activities for the partner universities was evaluated by assessing the staff's experience with sustainability-related teaching projects and knowledge of sustainability competency frameworks, the adequacy of student's skills, the level of academic training, and familiarity with key sustainability themes.

67% (48 participants) of staff across the four universities reported having experience working on sustainability-related projects or teaching sustainability concepts. These results may be biased, as individuals with a stronger interest in sustainability were likely more inclined to participate. Environmental training (20%) and

science/technology (43%) were the most prevalent specialisations among staff. This distribution aligns with the survey's broader dissemination within the engineering departments.

Despite the staff's background, over 60% reported not knowing about sustainability competences frameworks. These frameworks are recognised as providing common ground and guidance for learners and educators, advancing a consensual definition of sustainability competences, and responding to the growing need for people to improve and develop the knowledge, skills, and attitudes to live, work, and act sustainably (European Commission, 2024).

Recommendation 2: Establish and promote the use of Sustainability Competence Frameworks to assess the quality of sustainability teaching and to identify best practices and gaps in sustainability offerings

Approximately 32% of the staff believed that students had sufficient skills to meet the sustainability requirements of the job market. The best assessment of students' skill sets was that of the IPL staff, with 52% believing their students had adequate sustainability skills. Although the response may indicate that the staff was uncomfortable with the question, it confirms a general lack of confidence in students' sustainability competences.

The inadequacy in training was again reflected by participants when they were asked to rate their level of academic training, with 51% confirming that either they were extensively or adequately trained. Participants from Metropolia University (59%) expressed the highest satisfaction with their level of academic training.

In analysing the awareness of sustainability concepts, 40% of participants indicated they were either extremely familiar or familiar with these concepts, with staff reporting higher familiarity than students. The most familiar concept was the greenhouse gas effect, which over 80% of participants reported being extremely familiar or familiar with. The least familiar concept was the three core elements of sustainability/sustainable development. The campus most familiar with the aforementioned concept was IPL (54%), closely followed by the UPHF campus with 52%.

A further analysis of the awareness level of participants was done by assessing their knowledge of mechanisms involved in climate change. Although participants demonstrated a satisfactory level of knowledge relating to the causes and consequences of climate change, the results also indicated that there is a need for further knowledge building as 80% of participants attributed water pollution as a contributing factor to climate change, and 30% agreed to or were unsure as whether climate change led to decreasing sea levels.

Although education is recognised as crucial for enhancing people's ability to understand and address environmental and developmental issues, insufficient attention has been given to integrating and emphasising sustainability within education curricula (Michael et al., 2020). This may not be the case for all the case studies under review. However, the results point to a sense of dissatisfaction among staff and students, misalignment between training and meeting the demands of the job market, and the need to address identified knowledge gaps. Adjustments in the curricula of participating universities should be treated with a greater sense of urgency and targeted efforts.

These adjustments should ideally feature some aspect of active learning methodologies. Methodologies incorporating real-world experiences, problem-based learning (PBL) and case studies should be based on current topics relevant to students (Martinez et al., 2021). It is also crucial to make students feel like they are at the centre of these teaching activities and involved in solving challenges, thereby increasing their acquisition of sustainability competences and skills (Torp and Sage, 2002). Staff recommended resource management and pollution control as the most relevant curriculum entry points into sustainability and, therefore, should be prioritised when new teaching activities are being considered.

Recommendation 3: Execute a comprehensive curriculum analysis to explore best-case practices within the EFEU Consortia and associated institutions of higher learning that incorporate active learning methodologies, address urgent sustainability challenges, and develop necessary competences and skills.

5.3 Sustainable Attitudes and Behavioural Practices

Several notable observations were made while exploring participants' attitudes and behaviour. Most participants expressed concern over the climate change issue, with 76% of participants viewing climate change as a significant concern and 89% of participants seeing climate change as a threat to both present and future generations. Per group, the topic of climate change was seen as most significant to the Portuguese participants (87%), although the group reported being less affected by climate change (43%). These results indicate that although groups may perceive themselves as being unaffected by climate change, they recognise the relevance of the climate crisis and are concerned about its current and protracted threats.

The results also confirmed that participants attached value to environmental issues, as 86% expressed that climate change is as important as social and economic issues. Over 50% of participants believed climate change was too complex to address. The findings revealed a mixed perspective: Participants are hopeful about combating climate change, yet they lack a complete understanding of the complexities involved in addressing the crisis.

Participants (86%) recognised that the current rate of climate change is attributed to human activities. Nevertheless, only 47% reported participating in climate action or sustainability practices. The most active groups were staff (66%) and Portuguese participants (54%). Participants also recognised the role of governments and industries, with 66% viewing these parties as crucial in the fight against climate change. These views demonstrate that participants recognised the role of human activities in the climate change phenomenon and the relevance of governmental agencies and the industrial sector in implementing mitigating measures. The results also indicate the lack of personal commitment to the climate change fight.

Though participants demonstrated pro-environmental or sustainable attitudes, these attitudes do not translate into sustainable behavioural practices. This observation aligns with findings by Carrington et al. (2014) and Juvan and Dolnicar (2014), who stated that positive environmental attitudes and intentions are, unfortunately, not always and entirely reflected in people's behaviour.

Many participants did not attribute knowledge, cost, time, or difficulty in implementing sustainable practices as limiting factors in behaving sustainably. However, they acknowledged (61%) that their universities were not doing enough to promote sustainable behaviour. The Portuguese respondents (51%) reported the best performance, which was closely followed by Metropolia (47%).

These findings highlight the relevance of suggestions by Dabija et al. (2017), who recommended that understanding the causes and impacts of key factors, including their linkages (environmental, education, social, etc.) in building sustainable behaviour, should be a focal area in curricula of universities. It will be necessary to measure how selected sustainability topics or learning activities implemented or intended for implementation impact students' understanding, attitude and behaviour.

Recommendation 4: Implement surveys and further research to determine factors that limit sustainable behaviour and if and how these factors can be addressed.

Recommendation 5: In addition to implementing innovative modes of teaching, employ and enhance incentives, policies, awareness campaigns, etc that motivate behavioural shifts

5.4 The Impact of Education on Awareness, Attitudes and Behavioural Practices

The hypothesis that advanced education enhances awareness, attitude and behaviour was tested by assessing the views of 1st, 2nd and 3rd year students. The findings demonstrated no direct correlation between increasing educational levels and awareness or pro-sustainability attitudes. All categories demonstrated minimal involvement in sustainable behavioural practices. The results show insufficient alignment with the notion posed by researchers such as Hsu (2004), Roth (1992), Sia et al. (1986), and Michaels et al. (2020), who proposed that increased environmental awareness, pro-environmental attitude and sustainable behaviour of individuals are reflected in the increase in environmental knowledge. It is essential to note that the survey sample was small and the analysis was limited to only bachelor students.

The focus group also revealed that although satisfaction in sustainability training increased from year one to year three (41%, 51%, and 60%), students did not feel that their universities supported them in acting sustainably. 43% of first-year students, 37% of second-year students, and 28% of third-year students expressed satisfaction with their universities' performance.

Recommendation 6: Present findings from assessments, analyses, surveys, etc. to established focus groups or review committees, with a diverse mix of stakeholders including students, to facilitate open discussions on current teaching practices and the curricula, and to identify opportunities for refining sustainability offerings at appropriate intervals and stages of the university experience.

An overview of the critical elements that partner universities should consider for the sustainable transformation of educational frameworks is provided below.

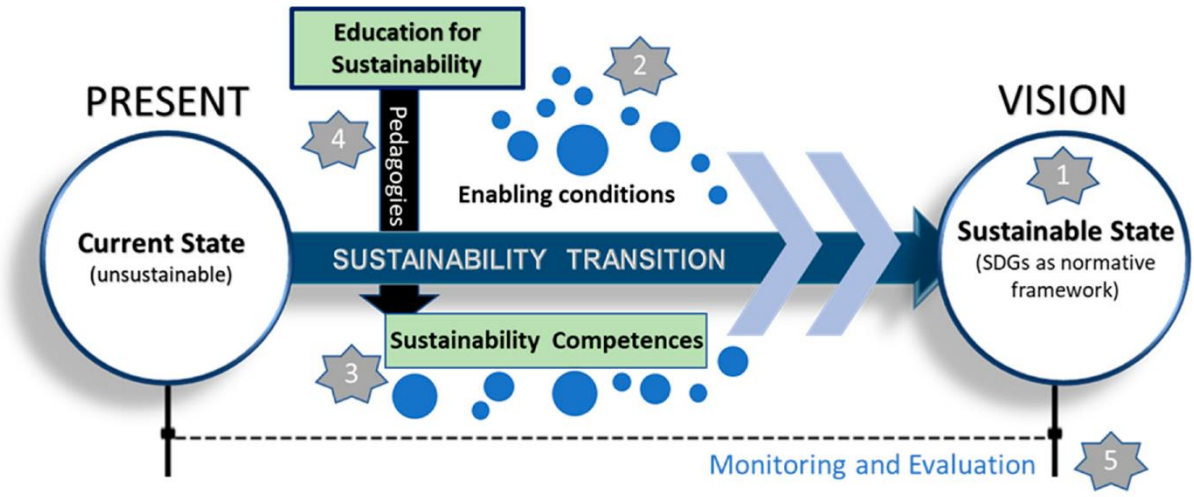

Figure 22: An Overview of The Education Framework for Sustainable Transformation (Kioupi and Voulvoulis, 2019)

6 Conclusion

Institutions of higher learning are invaluable players in the transformative shift needed to engender sustained thinking, attitudes, and actions that support sustainability. Therefore, universities must fully integrate sustainability aspects into their mission, vision, objectives, and philosophy. Moreover, consideration has to be given to formal committees, roles and responsibilities, assessment frameworks, policy, teaching, and, in particular, curriculum development that supports effective knowledge transfer (Malik et al., 2019).

This study revealed noteworthy conclusions and key considerations in the future development of the engineering programs of the included case studies. Firstly, staff (lecturers and administration) was underrepresented. Staff is essential in the sustainable education discourse. Both administration and lecturers must work collaboratively to create a culture of sustainability within educational institutions. This holistic approach ensures that sustainability is embedded in every aspect of education, from policy to practice.

Secondly, though the partner universities provide ample training opportunities, these have to be uniquely tailored and crafted to meet the sustainability demands of the job market and support the necessary attitudinal and behavioural shifts. An overarching goal is that relevant knowledge is transferred to the university community so that members are conscious, conscientious and proactive agents of the sustainability movement within their personal and professional realms. A more immediate and specific goal is to ensure staff and students are more knowledgeable about basic and pertinent concepts such as climate change. Additionally, universities should continuously employ and enhance incentives, policies, awareness campaigns, etc, that increase awareness and motivate sustainable behaviour.

Thirdly, universities must ensure that the quality of sustainable learning and teaching activities is measured regularly. As assessments (e.g., competence framework, curriculum analysis, sustainability certificates, and sustainability awareness surveys) provide an overview of baseline conditions, it is strongly suggested that partner universities incorporate them to track their performance. These are valuable instruments as they identify strengths, weaknesses, and opportunities for

advancement. The results of these assessments must be shared with the universities' stakeholders, in particular students, to ensure their views and recommendations are integrated into key decision-making processes.

It is fair to conclude that partner universities, like many other educational institutions, facilitate knowledge transfer, capacity building, and raising awareness of critical sustainability issues. However, these universities need to make the necessary re-adjustments to more closely align with the global standards for education for sustainable development and evolving demands within the field of engineering. As engineers are tasked with tackling the increasingly complex societal challenges of the 21st century, higher education institutions must rethink their approach to preparing them for the future. The results of the EFEU will prove crucial for guiding the next steps for the four partner universities.

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