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Fundamentals of a Sustainability Profile of Students based on Quantitative Community Building Analyses

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ABSTRACT:
In the context of a growing awareness of environmental challenges and the importance of sustainability values, practices, and choices, this article presents the key findings of the European co-funded NEMOS research project (A New Educational Model of Sustainability Competences through Service-learning) focused on defining the sustainability profile and competencies of students through service-learning in Higher Education. A community-building bottom-up methodology was innovatively applied to identify the competencies needed to define a sustainability profile of students in food-related degrees of five European Higher Education Institutions.
The research findings highlight the need for a holistic understanding of students´sustainability, including economic, social, and environmental aspects, as well as the importance of specific sustainability training for lecturers. Furthermore, it underlines the essential role of service-learning as a pedagogical approach to foster students´active participation in the community and to prepare them to address global challenges in a meaningful way.

Keywords: higher education, key-competencies, service-learning, sustainability profile

1. Introduction

In a world marked by the urgency of addressing climate change and environmental challenges, sustainability has become an educational imperative that must be incorporated into the learning environment at all academic levels. The UN Brundtland Commission´s definition of meeting present needs without compromising those of future generations has become more relevant than ever (World Commission on Environment and Development, 1987). In 2015, all UN Member States adopted Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable Development.

The relevance of SDGs lies in their ability to inform public policy and guide educational planning, thus fostering a holistic and interdisciplinary approach to building a more just, equitable, and sustainable future. Today, around 140 countries are looking for ways to meet their developmental needs, but with the growing threat of climate change.

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Concrete efforts must be made to ensure that the current progress does not negatively affect future generations. The aim is to find a solution to the issue of economic growth and the protection of the social and environmental balance (EU, 2023). In this context, the agri-food sector, with its significant impact on the environment and society, plays a critical role.

A recent systematic literature review on sustainability in higher education by Rodríguez-Zurita et al. (2025) found a significant shift from curriculum development (2000–2010) to education for sustainable development (2011–2022), and the effectiveness of experiential learning teaching approaches. These strategies include combining service-learning (SL) with community involvement and applying innovative research methods to enhance sustainable development competencies (ibid.). Their results indicated that stakeholders ought to integrate experiential learning activities and adopt innovative research approaches to advance education in, for, and about sustainability (ibid.). However, a few universities have been successful in implementing it holistically, integrating all the triple bottom line dimensions in balance (Menon & Suresh, 2020). Given these multifaceted challenges, it is imperative for Higher Education Institutions to equip students with the necessary knowledge and skills to address them, and build new partnerships and cooperation mechanisms (Owens, 2017). Developing a food sustainability profile for students that addresses the three dimensions of sustainability - environmental, social, and economic make Higher Education Institutions play a pivotal role in preparing students to contribute to the transition towards more sustainable food systems. This approach, coupled with the service-learning approach, ensures that students not only understand the interconnectedness of environmental degradation, social inequality, and economic disparity within the food industry, but also empowers them to actively engage in solutions that promote sustainability and equity. Through holistic education that integrates sustainability principles across disciplines, students can become agents of positive change, driving innovation and fostering resilience in the face of complex global challenges.

Sustainability is now established as a central concept in science and socio-economics. Its importance is intrinsically linked to the recognition of the imperative need to balance human progress with the preservation of natural resources and regenerative capacity of the biosphere. The term "sustainability" has been the subject of multiple definitions and approaches, reflecting its multidisciplinary nature and deep involvement in a variety of fields of study. In this context, the definition of sustainability should offer a holistic view of the concept. More recently, a justice perspective has been proposed to define safe and just 'Earth system boundaries' and to identify transformations towards living within these boundaries (Rockström, 2021). This approach underlines the urgent need to adopt practices and policies that promote sustainability as an essential goal for the well-being of present and future generations.

2. Theoretical Background

2.1. Pedagogies associated with sustainability learning

Recently, there has been a progressive shift from teacher-centered to learner-centered pedagogical approaches, which has increased students' ability to support

competence development, especially when dealing with topics such as sustainability (Barth & Michelsen, 2013). Sustainability skills are transversal soft skills that cannot be directly taught, despite being possible to develop. Therefore, it becomes necessary to associate pedagogy, intended as the art of teaching, with the development of these skills (Lozano et al., 2017). Through such approaches, students become active actors in the learning experience, as they can build direct relationships with community stakeholders, by means of their university lecturers, which involve them in sustainability-dedicated initiatives and drive transformations in students.

Sipos et al. (2008) refer to this as transformative sustainability learning (TSL). Students´engagement involves their "heads, hands, and hearts". This means that such pedagogies can stimulate both cognitive and affective domains. Academic study is, therefore, combined with an understanding of sustainability and global citizenship with practical skill development and the opportunity to elaborate and prototype ideas. During the learning path, there can be a change in values and attitudes, which can lead to responsible behaviors. The same authors mention some pedagogies that they consider transformative and rely on interconnections among disciplines (inter- and transdisciplinary), practical wisdom (experience), and relevance of the context (place-based). Moreover, in their study, Lozano et al. (2017) discussed pedagogies used universally in many disciplines (e.g., case studies, interdisciplinary team teaching, lecturing, mind and concept maps, and project and/or problem-based learning), community and social justice pedagogies (community service-learning, jigsaw/interlinked teams, participatory action research), as well as pedagogies for environmental education practices (eco-justice and community, place-based environmental education, supply chain/Life Cycle Analysis - LCA-, and traditional ecological knowledge). These authors point out that these pedagogies, combined, can better respond to Education for Sustainable Development (EDS).

Uncertainty, complexity and interdisciplinarity are the basis of sustainability challenges: when addressed through such pedagogies, the latter can support students' competence development (Barth & Michelsen, 2013). The emerging competencies concern both a systemic level, referring to the wider social sphere, and a personal one, as they can guide individual choices (Dlouhá et al., 2019).

2.2. Contextualisation

In a global context marked by the 2030 Agenda, sustainability will become one of the primary values that govern future societies and a key competence for the student body in the coming decades. This article is framed within the NEMOS project (A New Educational Model of Sustainability Competencies through Service-learning), which links sustainability, service-learning, and agri-food sciences to demonstrate how SDGs can be achieved (NEMOS, 2022-2024). The main objective of the project is to provide an educational model, based on service-learning, complemented by a set of tools for educators to integrate the development of sustainability competencies in higher curricula education (Cantalejo et al., 2024). The model was first developed in academic programs related to food education subjects, and then piloted, validated, and made available and transferable to other educational fields. Implementing strategies in a systematic manner, aligning with academic recommendations such as those by UNESCO (2020), and WFF

(2023) emphasize that sustainability within the agri-food system is multifaceted and can be effectively addressed by higher education institutions through active engagement, collaboration among various stakeholders, and interdisciplinary approaches. Within the framework of the project, a collaborative process was initiated to pool the knowledge and experience of five Higher Education Institutions (HEI) working together to implement in practice new educational models to effectively acquire sustainability competences through Service-learning in food-based degrees. Each institution had a different educational food-based programme and started from a different baseline in terms of experience and practice in implementing sustainability through Service-learning (SL). Taking into account the local contexts, institutional cultures, and national frameworks, a strategic partnership was needed to define a new educational model for integrating the sustainability competences through service-learning to redevelop the degree curriculum to reflect this, and to devise new learning resources, which in turn will impact on our students' learning and their way of working as food sustainable graduates. Therefore, we formed an international partnership of five European universities (Public University of Navarre -UPNA-, Spain; Technological University Dublin -TU Dublin-, Ireland; University of Pisa- UniPI, Italy; Graz University of Technology -TU Graz-, Austria; ISARA-Lyon, France) and the IGCAT International Institute of Gastronomy, Culture, Arts and Tourism (an EU-wide Network) to synthesize their expertise and to collaborate on developing the skills, attitudes and values for implementing the SDGs, helping students to be active in preserving our environment and in being conscious of their impact on society and in promoting a critical attitude to be responsible for sustainable consumption and rural development, linked to food production. After having done an in-depth analysis of needs based on the structure of the curricula and the courses contents, the partner universities detected that the sustainability as a transversal competence was not included in the food degrees' curricula and, therefore, to integrate sustainability in an effective way in the students´curricula, the service learning methodology is required to connect the participation of the broader educator and learner community to commit to sustainability by providing ways for decision-making and actions to extend the lessons learnt to the society.

Likewise, strategic partnerships are imperative to work on how to integrate core competences in sustainability (UNESCO, 2020) and that is the proposal of this research work, which was developed in the Food related Degrees with a multidisciplinary vision, to avoid influenced data collection and interpretation, ensuring a more context-sensitive sustainability model. Therefore, student learning from real-world problems and how to solve them in a holistic manner was the focus of this research, enabling them to anticipate and be prepared for future challenges in sustainability. Education for Sustainable Development in Higher Education requires rethinking learning environments to inspire students to act for sustainability. The implication for students is that they must play a leading role and be responsible for their own learning process from the very beginning, that is, from the first year at University to the last one, to enable them to live sustainable lives and to work in a sustainable economy. Moreover, thanks to the service-learning methodology, students will develop a sense of social responsability, civic engagement and connection with society that will go further than the inner circle of the university.

2.3. Research Objectives

This paper aims to define and provide tools and methodology for developing a sustainability profile of students, which is a crucial step towards integrating the acquisition of sustainability competencies into curricular education. Specifically, this study defines the Food Sustainability Profile (FSP) of students through a community building methodology by developing an intervention model common to the five higher education institutions involved in the project, focusing on sustainability and pedagogical practices, including service-learning. First, the qualitative and quantitative community building methodology is detailed. Food sustainability profile competencies and skills are then presented. Even if initially focused on food-related programs, this sustainability profile methodology has the potential to be extended to other fields of study.

3. Methods

The research methodology used for the first part of the NEMOS Project is the so-called "community building" or "bottom up" methodology, which is an essential approach in the study of contemporary social dynamics. This methodological approach has gained increasing relevance in sociological research because of its capacity to approach social phenomena in a comprehensive and profound way from the perspective that prioritizes the active participation of communities and social actors in the construction of knowledge and decision-making (Ballestín & Fabregués, 2018; Herzog & Ruiz, 2019). This methodology includes both quantitative and qualitative research methods among the actors involved, including students, lecturers, and social agents, with the aim of determining the sustainability profile of the student body (**Figure 1**). It also seeks to understand how various elements of an educational community can contribute to the configuration of a student sustainability profile. The main purpose of this research was to identify the competencies needed to define the sustainability profile of the university student body in studies related to the specific field of food-related degrees.

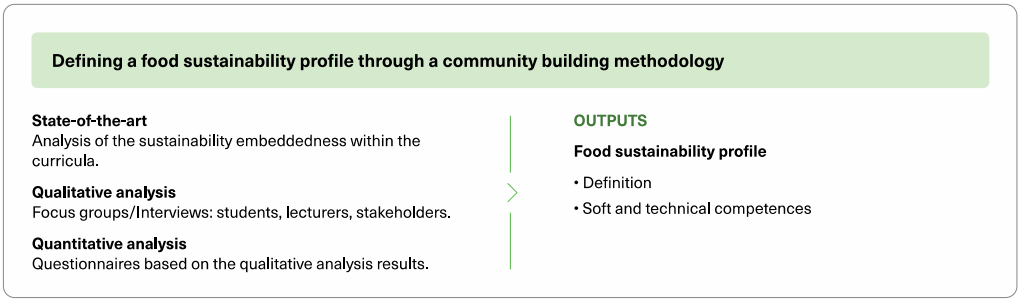

Figure 1. *Summary diagram depicting the overall research design to build a sustainability profile for students in the frame of the NEMOS project.*

Initially, we defined a pre-model of intervention common to all the universities involved. This entailed literature review both at educational and subject-field level on sustainability and pedagogical practices. Then, we consulted, involved and called for action of local communities, building up existing networks and enlarging them. This activity

included meetings, surveys and any other suitable channel to involve communities (companies, associations, citizens and general public, and policy makers). Also, teachers, tutors and support staff were consulted, involved, and called for action. Furthermore, drafting and delivering of the processes' outcomes served as a basis for the project result design and development. An analysis of strategic documentation informing food sustainability was undertaken, providing a basis for mapping existing curricula to core sustainability concepts. Using these mappings as artefacts for interviews and expert-focus groups with key stakeholders (i.e. staff, students, sustainability experts and professional field) across the 6 project partners, an ideal Food Sustainability Profile (FSP) for students was developed, integrating the different skills and technical capacities that define a knowledgeable student in food sustainability. A series of pedagogical interventions (Service- Learning included) was then designed and piloted to develop students' FSPs. Both educators and learners were actively involved in this action-research process with the final set of methodologies (MH) documented as guidelines for adoption and transferability to other disciplines. Assesssment tools of FSP and MH were developed to enhance validity and they acted as an auditing instrument for evaluating the integration of sustainability through SL within Food related degrees. The quantitative research fieldwork carried out by the five NEMOS project Higher Education Institutions and IGCAT included: Stakeholders, 55; Students, 286; Lecturers, 79. Therefore, the data collected firstly qualitatively, through interviews, focus groups and groups of discussion and secondly quantitatively, through 3 surveys, whose questions were elaborated based on the answers given in the qualitative analysis, served as the basis for this research work focused on the quantitative part of the research.

Specifically, first, a team of lecturers at each Higher Education Institution conducted a comprehensive analysis of curricula. They reviewed each subject offered in the curricula, focusing on technical skills, their alignment with the SDGs and sustainability, and strategies for effectively enhancing or incorporating these skills.

Second, conducting a qualitative approach prior to quantitative research was seen as an essential step in the process of delineating the sustainability profile of the university student body. This qualitative phase offered the opportunity to explore in depth the attitudes, perceptions and values of the research actors, as well as to identify relevant main lines of inquiry. By using qualitative methods, such as in-depth interviews, groups of discussion or focus groups, the complexity of opinions and perspectives of students, faculty and stakeholders could be captured more accurately, which facilitated the definition of variables and the formulation of relevant questions for subsequent quantitative research (Ruiz Olabuénaga, 2012). In addition, this qualitative approach allowed for the detection of emerging themes and key aspects that might have been missed in a purely quantitative approach, thus contributing to a more complete and contextualized understanding of sustainability in the university environment.

Table 1 summarizes the fieldwork carried out in the qualitative research conducted by the project members. The number of focus groups and discussion groups refers to the participants in the study, including stakeholders (local food industries, civil society organizations, and regional and local government departments), students and lecturers, interviews with stakeholders (local food industries, civil society organizations,

and regional and local government departments) and lecturers carried out by each Higher Education Institution.

Table 1. Qualitative research fieldwork carried out by the five NEMOS project Higher Education Institutions: Technological University Dublin (TU Dublin), University of Pisa (UniPI), Graz University of Technology (TU Graz), Higher Institute of Agriculture Rhone Alpes I.S.A.R.A.-University of Lyon (ISARA) and Public University of Navarre (UPNA).

Number of Focus Groups	**TUDublin**	**UniPI**	**TU Graz**	**ISARA**	**UPNA***
Stakeholders		2	1	1	4
Students	1	2	1	1	1
Lecturers	1	1	1	1	2
Number of Interviews	**TUDublin**	**UniPI**	**TUGraz**	**ISARA**	**UPNA**
Stakeholders	6			10	
Lecturers		5			

*Discussion groups exclusively for UPNA.

In the case of the discussion groups carried out solely by UPNA, a generic topic construct to open the group discourse was used, whereas open questions were used both for focus groups and interviews, based on the literature (Akins et al., 2019; Corres et al., 2020; Bianchi et al., 2022).

Third, based on the information provided by the discussion groups, focus groups, interviews, and literature (McCarthy & Eagle 2021; TEFSI 2018-2021), three modalities of questionnaires were designed for the surveys (for students, lecturers and social agents). The student, lecturer and stakeholder questionnaires used for quantitative research can be found in Cantalejo et al. (2024, p. 57). The definitions of the technical parameters of the survey process, recording, and code validation of the questionnaires were carried out by the NEMOS project research team. The questionnaire for lecturers, composed of 49 items, prospectively addresses various thematic issues related to the research objectives from a quantitative perspective.

In the initial section, there was a set of questions aimed at defining the typology of the teaching staff. In addition, for items related to interest in sustainability issues, the use of a 5-point scale has been a methodological strategy to quantify and assess participants' attitudes and perceptions of sustainability issues. This five-point Likert scale allowed researchers to measure the degree of interest in a variety of dimensions related to sustainability, such as environmental awareness, concern about climate change, and willingness to adopt sustainable practices, among others. In fact, the potential role of unified frameworks, such as GreenComp, (Bianchi et al, 2022) in balancing localized teaching practices with common competency goals was key to agreeing on a common criterion for all universities involved in this study.

The recording of the questionnaires and their verification through internal consistency tests were carried out by the technical research team using Barbwin 7.0. The fieldwork was conducted by project staff from different Higher Education Institutions. Some teams carried out surveys in person with the interviewees, but most of them were completed online.

In accordance with the Declaration of Helsinki (2013), our study adhered strictly to ethical research practices. Participants were fully informed about the purpose and voluntary nature of the study, and verbal consent was obtained prior to their involvement. The questionnaires were administered in paper format and completed anonymously, with no collection of names, signatures, or any personal identifiers, thereby ensuring the full confidentiality and privacy of all respondents. In addition, the anonymous nature and the possibility of not continuing to participate at any time during the study were recalled. All participants were of legal age and were aware of their legal rights before the research. In the present research, informed consent was used with a systematized protocol in both the qualitative (focus groups) and quantitative (sociological survey) methodological processes. The period of the data collection was from April to October 2022. Neither in the questionnaire nor in the group dynamics were there variables and/or questions that made it possible to identify persons, personal and/or professional categories. Both the questionnaires, the databases, and the texts of the sessions, were not used in the group dynamics.

The quantitative part of the results presented two lines of analysis: univariate analysis in descriptive graphs of the percentage data for each item and bivariate analysis by crossing, in contingency tables, and different independent variables. In the case of lecturers, these variables were gender, age, university, and level of interest in social, political, economic, and/or environmental issues, as well as interest in sustainability, knowledge of the SDGs, participation in sustainability projects, and knowledge of service-learning. To measure the statistical association between variables, the chi-squared test (X^2), indicated by the symbols: < / >, was attached to the cells of the contingency tables. In addition, for the numerical-scale variables, the arithmetic means and standard deviations of the values obtained in the responses are presented. All percentages presented in this paper, which are the result of the different crosses between variables, have statistical significance when applying the chi-squared test. The Barbwin program indicates the association existing in each of the different cells of the data contained in the contingency tables drawn up in this study.

Although each university conducted its own analysis and database independently, a common database was created with the results of the surveys conducted among the teaching staff of the five Higher Education Institutions, whose most relevant information is presented in this article and complemented by the most relevant results of the surveys conducted among students and social agents. **Table 2** summarizes the fieldwork conducted by project members in the quantitative research.

Therefore, the data were collected first qualitatively through interviews, focus groups and groups of discussion, and quantitatively through three surveys, whose questions were elaborated based on the answers given in the qualitative analysis, served as the basis for this research work focused on the quantitative part of the research.

Table 2. Quantitative research fieldwork carried out by the five NEMOS project Higher Education Institutions and IGCAT.

Number of surveys	**TU Dublin**	**UniPI**	**TU Graz**	**ISARA**	**UPNA**	**IGCAT**	**TOTAL**
Stakeholders	2	16	7	15	8	7	55

Students	39	38	12	94	103	--	286
Lecturers	21	18	8	15	17	--	79

4. Results

4.1. Facing the challenges of sustainability in Higher Education: Lecturer perspectives

4.1.1. Lecturer perspectives on sustainability

For the most part, the prevailing definition of sustainability among lecturers can be expressed as: "The efficient management of environmental, economic and social resources to ensure their sustainability over time, without compromising future generations". An average score of 4.3 points was obtained for interest in sustainability related issues.

The issues most related to sustainability are the Environment, Food Production and Energy Expenditure, as well as a set of issues in general. It is significant that those who showed little interest in social, economic, and political issues associated sustainability primarily with industry. This may imply that they view sustainability primarily through the lens of industrial processes, the environmental impacts of businesses, or corporate responsibility, rather than considering broader social, economic, and political dimensions of sustainability. UNIPI respondents most frequently said that sustainability is related to all aspects of life (55%).

Another aspect addressed in this study is the collective knowledge of internationally adopted SDGs. More than 70% of the respondents were aware of these goals, although this percentage was lower among those with a low interest in sustainability.

The five SDGs most frequently mentioned by the lecturers were Zero Hunger, Health and Well-being, End of Poverty, Climate Action and Clean Water and Sanitation. Among TU Dublin lecturers, the goals of Affordable and Clean Energy were mentioned more frequently than others. The majority of lecturers were involved in sustainability-related projects, both as lecturers (40.5%) and professionally (49%), and they were people whose everyday behavior was mostly sustainable (69.8%). The five daily activities that they carry out most frequently are recycling, responsible consumption, clean mobility, controlling energy consumption, and using recycling points. When making purchases, they also pay special attention to the origin and, in the case of ISARA lecturers, confer particular importance to products of organic origin.

Regarding issues related to Sustainability and Education, 85.3% included content on sustainability in their subjects, although this percentage decreased significantly among UPNA lecturers (35.3% who did not). Furthermore, most of them (77.7%) encouraged students to develop sustainable practices in their daily lives. In the development of their teaching activities, 72.1% considered the control of waste and the consumption of energy and materials, both in the classroom and in the laboratories, and the teaching staff considered that sustainability is somewhat present in the contents they teach, with an average of 3.3 on a five-point scale.

In this section, significant differences in perceptions of sustainability presence in the degrees among lecturers from various Higher Education Institutions were observed, with ISARA faculty rating it as very present, while UPNA rated it as not very present, and TU Dublin and UNIPI fell in between intermediate values (**Figure 2**).

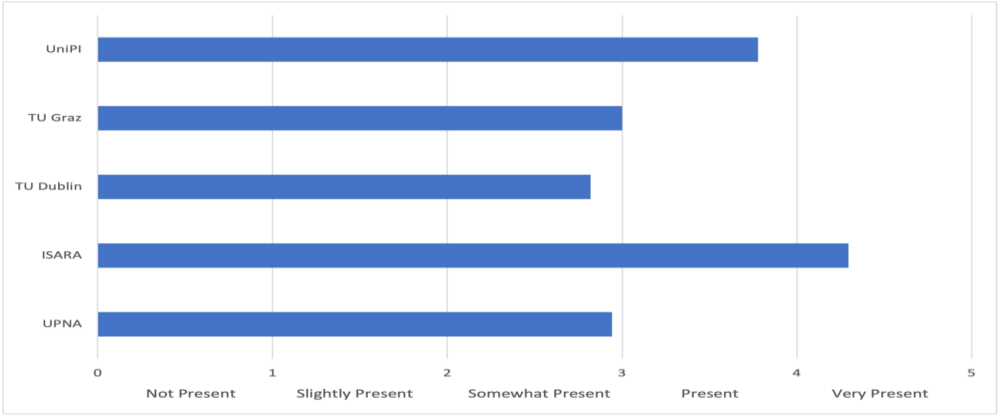

Figure 2. *Presence of sustainability in the Bachelor's or Master's Degree according to each Higher Education Institution involved as NEMOS project partners. The scale in the graph represents the five-point Likert score.*

83.7% of the participants agreed on the need for greater integration of sustainability in the university schools where they teach, with a slight decrease in the case of ISARA, where this percentage is 76.5% (**Figure 3**).

In relation to the specific aspects in which further training is needed, the five most frequently mentioned were how to introduce sustainability in a practical way in the subject; varied general knowledge on the subject; tools for measuring and assessing sustainability; specific technical aspects; and how to incorporate the SDGs in the contents of the subjects. It is relevant to note that this last area was particularly in demand among UniPI respondents.

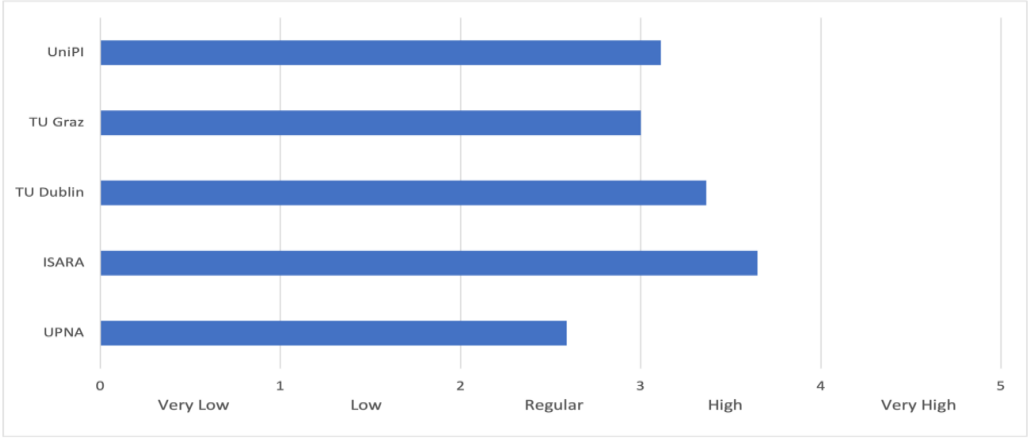

Figure 3. *Need for sustainability training according to each Higher Education Institution involved as NEMOS project partners. The scale in the graph represents the five-point Likert score.*

The initiatives that are currently being undertaken to promote sustainability are practical classes on the subject, environmental costing, and the water/energy saving guide. However, 10.9% of lecturers indicated that they did not implement any sustainability-related initiatives, with a significant increase in the case of UPNA lecturers (35.3%) and in the group not involved in sustainability projects (37.2%). Among the group with less interest in sustainability, one of the most frequent initiatives was the control of laboratory waste (17.1%, compared with 5.9% of all teaching staff).

Regarding the initiatives that they would like to see in their bachelor´s and masters programs, the most frequently mentioned was the implementation of multidisciplinary work on sustainability (26.4%), followed by the incorporation of sustainability as a transversal competence (20.6%). It is important to note that a significant percentage (26.6%) did not provide a definitive answer to this question. Most of the teaching staff were in favor of participating in projects related to sustainability (88.6%). Regarding the assessment of student involvement in sustainability issues, the lecturers rated it with an average of 3.2 out of 5 points, with a slightly higher score in the case of ISARA (3.7) (**Figure 4**). However, the assessment of the involvement of the teaching staff at their respective universities was considerably lower, with an average of 2.9, with ISARA having the highest score (3.5) and TUGraz the lowest (2.6).

The reasons behind the low contribution of the teaching staff to sustainability issues, according to the perspective of the group interviewed and in order of importance, were mainly: lack of training in the subject, followed by lack of time and lack of motivational stimuli from their respective universities.

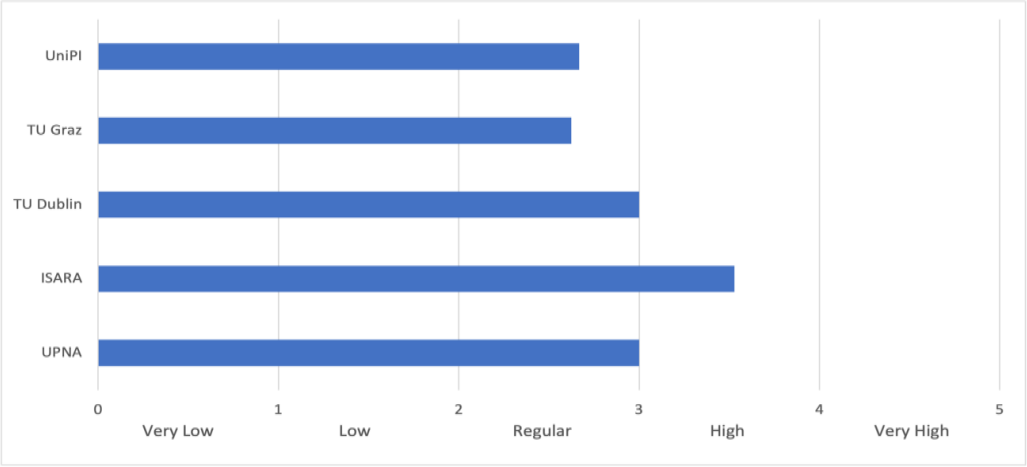

Figure 4. *Participation of lecturers in sustainability issues according to each Higher Education Institution involved as NEMOS project partners. The scale in the graph represents the five-point Likert score.*

With regard to the knowledge that university students should acquire in relation to sustainability, the most important aspect was the inclusion of sustainability as a transversal competence in all bachelor´s and master´s degree programs, with 38.3% of

responses, followed by the need for general knowledge of the subject, which was 21.7%. It is relevant to point out that 23.9% of the surveyed group did not answer this question, which indicates a lack of definition in this aspect. There was a majority consensus (82.5%) on valuing sustainability as a competence that benefits students in their future employment. It is also important for 82.2% of the teaching staff that this subject has a more prominent educational presence at their respective universities. The group interviewed at UniPI was less willing to answer this question, with 44.4% not providing an answer (in contrast to 8.5% of the overall percentage). This notably high non-response rate at UniPI (44.4%) may reflect uncertainty regarding how sustainability should be integrated into curricula, a lack of familiarity with relevant frameworks, or a lower level of engagement with the topic. Such factors constrain the robustness of the findings for this institution and limit the extent to which sound conclusions can be drawn about overall faculty consensus on integrating sustainability into Higher Education.

In relation to the sustainability initiatives implemented in their respective schools, more than half of the teaching staff said that they were aware of some, while 30.7% were not aware of any. In the case of UniPI, this percentage increased to 66.7%.

Defining what kind of initiatives could be implemented by their universities on sustainability issues was a question on which 24% of respondents gave no answer, while 28.5% considered that the universities' management bodies should be more committed to this issue. Other initiatives mentioned include improving energy management, carrying out training activities on the subject, and optimizing waste management in laboratories.

It is worth noting that almost half of the lecturers surveyed, specifically 48.2%, did not actively participate in any non-governmental organisation (NGO). In general, there was a high or very high level of interest in political and social issues, reaching a percentage of 78.4%. Furthermore, there was a clear correlation between the group exhibiting low interest in sustainability-related issues and those expressing regular or low levels of interest in social and political issues, amounting to 82.8%.

In summary, the introduction of the concept of sustainability in university education requires reflection on the part of competent educational administration, which establishes guidelines for action. It is essential, in light of the responses obtained from the teaching staff, to promote institutional support for the integration of sustainability in the university, with a transversal approach and the active participation of the university, businesses and social organizations.

4.1.2. Lecturer perspectives on service-learning

In this section, the attitudes and knowledge of lecturers in relation to service-learning are explored.

Of the teaching staff interviewed, 50.8% were unfamiliar with service-learning, while 49.2% were familiar with it (based on data from 79 interviewees in total, as indicated in Table 2). The UPNA teaching staff was the most familiar with this methodology (70.6%), while those at UniPI were the least familiar with it (11.1%). Despite this general lack of knowledge, the teaching staff were willing to incorporate service-learning training in their subjects, especially through internships and final projects. Furthermore, 76% would be willing to incorporate service-learning in their subjects, and 77.4% would be willing to develop service-learning experiences to promote a culture of service-learning

among lecturers and students. In the last two questions, the people interviewed in TU Graz were more undecided, and the percentage of unanswered responses was significantly higher than that of the general group. Finally, the vast majority (94.2%) would be willing to receive training on service-learning to be able to incorporate it into their teaching work.

As for reinforcing the responses obtained in the quantitative survey, it was considered interesting to complement them. In this section, some elements and questions that arose in the discussion groups held with lecturers in the previous qualitative survey, enriched and added value to this topic. In the context of promoting sustainability, the implementation of service-learning and challenge-based projects proved to be successful strategies to stimulate creativity and effectively address sustainable issues. To this end, it is essential to establish links with the business and social environment to identify specific needs that can be realized through projects of this nature. Likewise, the importance of incorporating service-learning training in both bachelor´s and master´s programs was recognized, which would enable students to reflect ethically in their respective fields of study.

Furthermore, the experience of the teaching staff in the application of methodologies of this nature was emphasized, as it would contribute to the strengthening of students´ competencies and skills, as well as their motivation in the context of these projects. Finally, the discussion groups highlighted that the role of the teaching staff was significantly transformed, going beyond the mere transmission of theoretical content to exert a substantial influence on the attitudinal and behavioral aspects of the students in the area of commitment to environmental, economic, and social sustainability

4.2. Development of sustainability in Higher Education: students and stakeholders

This section explores, in a synthetic way, the responses, attitudes and interests of the students involved in the project and stakeholders, including public and private collectives and companies related to sustainability.

4.2.1. Student and stakeholder perspectives on sustainability

In general terms, in response to the open-ended questions, the student collective defines sustainability as: "ways of producing, consuming and living efficiently and respectfully in all areas (social, economic and environmental)". This definition emphasizes the importance of balancing social, economic and environmental aspects in the search for sustainable development.

On one hand, stakeholders also highlight the three pillars of sustainability (environment, society, and economy) in their definitions. They emphasized "food quality", "quality food systems" and their management, "preservation of resources", "reduction of environmental impact" and "social and individual well-being". These aspects relate to the long-term vision and approaches that allow sustainability over time. In general, it can be concluded that there is a clear convergence towards a common definition of sustainability among the student body, stakeholders and teaching staff. In terms of training in sustainability, students considered it to be regular, and that there were significant needs in a wide range of topics, from economics and social issues to specific technical aspects related to their fields of study. Topics related to climate change, such as indicators of

climate change and strategies to improve energy management and food production, were prominent in their responses.

The stakeholders, on the other hand, pointed out the need for further professional development on sustainability issues in their work, especially in the food sector. They mentioned the need for multidisciplinary knowledge including culinary skills, safety and hygiene, information technology, food preservation, and food-related economic skills. Both the student body and social partners showed a strong interest in participating in projects or activities related to sustainable development that considered environmental, social and economic factors. Students wanted projects that connected companies and organizations with the university to carry out practical activities in the field of sustainability.

In terms of actions to be implemented by stakeholders in their organizations, training activities for sustainability management were mentioned, including communication, customer relations, human resource management, risk management, service standards, sustainability plans and sustainability analysis in the value chain.

4.2.2. Student and stakeholder perspectives on service-learning

There is a general lack of knowledge of service-learning methodology among students, but at the same time, there is a clear interest in acquiring more knowledge about this tool. Students want to work with this methodology in practical projects in class and in subjects related to sustainability in their curricula. All groups interviewed agreed on the importance of sustainability education, in terms of knowledge, attitudes, and behavior. Sustainability was perceived as essential for future generations and for the success of companies and organizations in a world increasingly aware of environmental, economic and social challenges.

Job expectations vary among students from different Higher Education Institutions. In the case of the group interviewed at TU Graz and UPNA, they preferred to work in large and medium-sized companies, technology centers and educational centers. The ISARA student group tended to choose options related to cooperative companies, small farms or self-employment. Finally, UniPI students preferred to start their own business. From a geographical perspective, there were significant differences in the residential preferences of the European students. UniPI, UPNA, and ISARA students showed a marked interest in living and developing their careers in rural areas.

On the other hand, it is noticeable that the TU Graz respondents preferred options that combined both rural and urban areas in their residential and professional development choices. This approach can be attributed to the geographical structure and distribution of the population in Austria, where urban areas are effectively connected to rural areas and provide work and recreational opportunities. This variation in geographical preferences underlines cultural and regional diversity in Europe, providing an interesting perspective on the residential and occupational aspirations of the respondent population.

4.3. Towards a definition of the student sustainability profile in the educational field

Once the results obtained by the Higher Education Institutions involved in the project in their respective research had been analyzed, the formulation of the key competencies and aspects in terms of student sustainability was carried out. This student

sustainability profile has different elements: the general and broad definition of a sustainability profile, the necessary competencies that students have to acquire in order to achieve this sustainability profile, and, finally, the most appropriate methodologies to acquire these competencies. In this regard, two approaches were identified.

- On the one hand, there was the perspective in which sustainability was seen in a broad, general, multidisciplinary, systemic and holistic way. It encompasses sustainability in three aspects: environmental, social, and economic.
- On the other hand, the universe of study focused exclusively on environmental sustainability, both in their discourses and visions.

Finally, the NEMOS project partners decided to propose a definition for the sustainability profile of the students, which is presented in the following terms: Undergraduate students received transversal training throughout the curriculum with different levels of depth in social, economic, and environmental sustainability. Various aspects related to sustainability appear throughout the bachelor (or Master) degree in both the scientific and theoretical parts and projects. The service-learning methodology supports and reinforces the acquisition of these competencies and skills in sustainability received by the student body. There is a close relationship between universities, business networks, and social partners in developing service-learning projects on sustainability (Cantalejo et al., 2024).

Regarding the area that needs to be addressed to improve the sustainability training of university students, depending on how the definition of sustainability was approached, some points were more developed than others. The responses and results obtained were grouped in the project both in the quantitative and qualitative surveys, organizing the information into two main areas: technical skills and interpersonal skills. Technical skills included scientific and technical skills related to the operational functioning of bachelor´s or master´s students´ knowledge. The social partners and teaching staff indicated that technical knowledge would be developed more specifically in the company and less emphasis would be placed on specific technical competencies. In this line of argument, the development of interpersonal skills is considered more important for the student body and future professionals. However, it is important to note that the students themselves demanded more technical knowledge of sustainability through the degree and preferred specific topics rather than cross disciplinary training. They all agreed on the need for permanent renewal of curricula.

Interpersonal skills included transversal skills that can be considered common to any bachelor´s or master´s student. In fact, the results of some studies suggest that these skills should be worked on from the most basic educational levels. It seems clear that a selection of both types of skills should be established, so that the education students receive is comprehensive, and both humanistic and scientific. The four fundamental points that the student body should acquire are as follows: 1) Transversal and systemic vision to provide sustainability in all three aspects: social, environmental, and economic; 2) interaction with future changes (energetic, digital, social, etc.) with reactivity, adaptation, and curiosity; 3) critical thinking and problem-solving; 4) methodological rigor.

The main technical and scientific competencies and skills that contribute to developing sustainability are 1) a holistic and systemic approach to complex phenomena considering the three pillars of sustainability: social, environmental, and economic; 2)

knowledge of sustainability tools in agri-food systems: life cycle assessment, techno-economic analysis, social life cycle assessment, food laws/regulations, etc., 3) Energy, digital and social developments; 4) knowledge based on experience; and 5) ability to link theory and practice. As the understanding of sustainability and the challenges facing the food industry evolve, the topics and competencies required by professionals in this field may also need to be modified in the future.

The main transversal competencies and skills that develop sustainability are 1) the ability to adapt to change; 2) teamwork and collaboration skills; 3) systematic thinking and holistic vision; 4) relational and listening skills (empathy); 5) problem solving; 6) critical thinking; 7) leadership and ability to set priorities. Ideally, students should acquire 13 soft competencies. These competencies are in line with those suggested by the European Commission GreenComp competence framework for sustainability (Bianchi et al. 2022). We identified two additional competencies: communication and teamwork skills.

5. Discussion

The current study provides a quantitative methodology, based on a community building bottom-up approach, to develop a sustainability profile including the different attributes pursued by a food graduate student applying the service-learning methodology in higher education, offering an objective tool to be applied in food related degrees and probably in other disciplines and degrees. It is encouraging to note that awareness of the SDGs is high among the faculty of the five Higher Education Institutions analyzed, demonstrating a widespread awareness of global challenges. However, perceptions of sustainability in curricula vary across universities, suggesting that there is an opportunity for further integration.

Our research demonstrates the commitment of teaching staff to sustainability, both in teaching and daily life. However, the need for more specific training in sustainability is clear, as highlighted by several authors and organizations (Glavic, 2020; Pegalajar-Palomino et al., 2021; UNESCO, 2019). Specifically, our study identified the need to introduce sustainability into subjects and tools for measuring and valuing it.

When developing a sustainability profile, it is important to reflect on which pedagogies are more suitable for the type of learning. Methodologies such as service-learning might seem to be more appropriate for the development of competencies of a social and economic nature in sustainability, while more theoretical methods and student internships in companies would help more in the environmental and economic aspects of sustainability. However, relatively few published studies on environmentally related service-learning showed positive student outcomes based on student reflections (Bernot et al., 2017; Knackmuhs et al., 2017; Vance-Chalcraft & Goodwillie, 2022).

In some cases, lecturers are cautious about applying service-learning methodologies in compulsory undergraduate modules for fear of not being able to develop scientific competencies adequately, and therefore propose applying this type of methodology in non-compulsory modules of less scientific importance. However, in the results obtained by some of the partners who have experimented with these methodologies in compulsory subjects of the curriculum, there is a great willingness on the part of the teaching staff and, above all, students to receive more practical and less theoretical training

in the whole range of competencies linked to sustainability. Our findings reveal a strong willingness among teaching staff to integrate service-learning into subjects, particularly through internships and final projects, and a strong interest in receiving training on this pedagogical approach. It is worth noting a general lack of familiarity with service-learning methodology among lecturers, despite its pivotal role in promoting sustainability, fostering creativity, and enriching education with practical approaches and experiences that connect academic learning with community services.

Sustainability profile of students

Over the last two decades, there has been a growing body of literature defining and framing key sustainability competencies in higher education (Bianchi et al., 2023; Sipos et al., 2008; Wiek et al., 2011).

To our knowledge, no systematic and comprehensive methodologies or studies have focused on student sustainability competencies in the food sector. Regarding the competencies required, the need for a global and systemic perspective is emphasized, as well as the need for cross-cutting and the acquisition of technical and scientific competencies to address the challenges inherent in sustainability. The importance of reactivity, adaptation, curiosity, critical thinking, and methodological rigor is also emphasized.

In terms of training and learning expectations related to sustainability, the need for transversal skills linked to the three pillars of sustainability is emphasized, although students also express an interest in acquiring applicable technical and scientific skills. The need for a balance between theoretical and practical learning, as well as the constant updating of curricula, is argued. Social partners and lecturers expect future students to engage in meaningful dialogue between the three pillars and develop economic reasoning without compromising the principles of sustainability. Finally, the relevance of transversal and multidisciplinary skills in the competence profile of students was highlighted.

Figure 5 summarizes the definition of the sustainability profile of the students up to the pedagogical modalities and the competencies pursued as developed by the NEMOS partners. In relation to the definition of sustainability, a quasi-systematic association with the concept of sustainable development is evident, although a question is raised regarding the term "development" due to its economic, social and environmental connotations

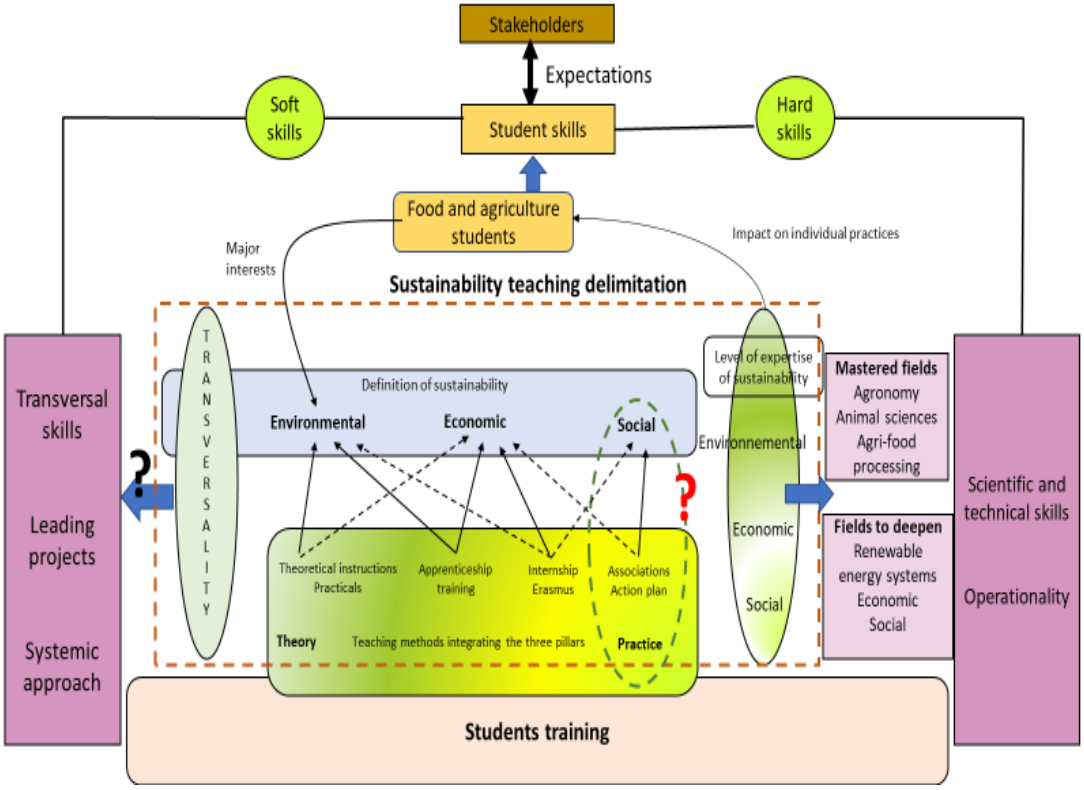

Figure 5. *Sustainability profile of students (FSP) through service-learning proposed by the NEMOS partners. The arrows suggest relationships between the different elements in the FSP.*

6. Implications and further research

The research methodology used, community building, emphasizes the active participation of communities and stakeholders in knowledge construction and decision-making. The results of this research highlight the growing importance of sustainability in Higher Education, in particular, in sustainable food systems education, and the need for a holistic understanding that encompasses economic, social and environmental aspects.

The successful development of a Food Sustainability Profile for students represents a significant step towards equipping future graduates with the necessary competencies and skills to address the complex challenges of food sustainability. The FSP underscores the importance of integrating technical and transversal competencies across the social, economic, and environmental dimensions of sustainability throughout the curriculum. By embedding these competencies at various levels of depth within both the theoretical and practical components of degree programs, students are provided with a comprehensive understanding of sustainability principles and their application in real-world contexts.

Moreover, the use of service-learning as a pedagogical approach has emerged as a pivotal strategy for fostering the acquisition of sustainability competencies and skills. Through collaborative projects with diverse stakeholders, including universities,

businesses, and social organizations, students engage in hands-on experiences that promote critical thinking, problem solving, and transformative learning. As a result, the implementation of the FSP not only enhances students' academic knowledge but also catalyzes profound personal and behavioral changes, positioning them as active agents of positive change in the pursuit of food sustainability. To strengthen its long-term validation, future research should track alumni from different disciplines to examine how competencies acquired through service-learning are applied in professional and civic contexts, thereby assessing its effectiveness beyond academia.

In the future, it is essential to continue promoting sustainability in Higher Education, fostering a shared understanding among faculty, students and stakeholders. This includes investing in sustainability education and practice, facilitating interdisciplinary collaboration, and addressing real-world challenges through innovative solutions. By embracing sustainability principles through service-learning, Higher Education institutions can nurture engaged citizens prepared to address environmental and social challenges for a fairer, more equitable and sustainable future. To address this, the study's findings illustrate how institutional reform can be advanced, emphasizing that embedding sustainability holistically requires systemic change, with this research serving as an initial but significant step.

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