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Editorial

Education for Sustainable Development in Higher Education-Introduction to a Special Issue

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Education for sustainable development (ESD) is essential for humanity to overcome the immense challenges it faces as a result of human actions on nature. For many students, higher education is the last step before they pursue a professional career. In a special way, the university experience can help students to become agents of change for sustainability. However, the opportunity to learn and adapt towards sustainability can also arise as a professional or active member of the institutions in which one works or collaborates. Lifelong learning, and in particular university education, should assist in the acquisition of competencies for sustainability as tools for facing the complexity of today's world. This is an overarching goal that many universities, professors, staff and research groups are aiming for.

This Special Issue sets out different educational methods and formats for bringing university students closer to the ideals of sustainability in its different environmental, economic and social dimensions. Some papers present experiences in educational activities or program design [1–3], teaching-learning sequences [4], learning contexts that facilitate ESD [5–8] or a person-centered approach to professional soft skills development [9]. Others analyze the sustainability competence status at the study level [10–12] and faculty level [13,14], student perception and knowledge of sustainability learning [15–19], or likewise propose strategies at the university level for the integration of sustainability and the Sustainable Development Goals (SDGs) [20] in degree curricula [21–23].

Different frameworks for integrating sustainability into degree curricula are explored, including developing competency maps [21–23]; developing a cross-curricular learning outcome [10]; shaping an interdisciplinary approach [6]; stakeholder integration [7], or even best practice certification for university staff [8]. Taken together, the papers provide a wide range of possibilities for moving education towards ESD. At the same time, they highlight the challenge posed in terms of the inclusion of ESD in higher education institutions, which are often too detached from individual students or employees who are ultimately the new agents of change.

On the path to social change, in her article, Aina Mammadova [7] proposed the expansion of the focus in order to integrate the local community and the government into the educational process. She proposed an integrated course whose curriculum was designed jointly with these actors, with the aim of increasing students' awareness and knowledge of regional sustainability. The two-year course "UNESCO Biosphere Reserves and Geoparks" includes practical visits to a geopark and a biosphere reserve. It provides site-specific knowledge and functions as a learning platform for both the students and the community involved. This strategic action is envisaged in the current 2016–2025 roadmap of UNESCO's Man and Biosphere strategic program. One of its four strategic objectives is "facilitating biodiversity and sustainability science, ESD and capacity development". Along with the experience, the students confirmed that they had significantly broadened their

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understanding of sustainable relationships between people and their environment, and had analyzed them in depth both at a community and global level.

In a further article, outdoor activities and fieldwork, which were shown to yield positive results for environmental education, were proposed as a learning context to facilitate ESD. Rico and colleagues [4], from the Department of Mathematics, Experimental and Social Science Education at the Universidad del País Vasco (UPV-EHU), designed an interdisciplinary teaching-learning sequence (TLS) on air quality for pre-service primary school teachers using an ecological learning garden and following active and constructivist learning strategies. The curriculum integrates STEM and sustainability competencies as well as concepts related to weather, climate, and pollution. Surveys on STEM content and a post-implementation STEM and ESD satisfaction proposal were conducted, while pre-post questionnaires reported on self-efficacy and the perceived relevance of ESD. The authors conclude that TLS is a transformative educational experience that facilitates ESD, which is linked to outdoor teaching and learning processes and metacognition activities.

Similarly, the introduction of the social aspect results in a learning context that facilitates ESD. A good service-learning practice is presented in the paper by Sánchez-Carracedo and López [5]. A program to repair, recycle and reuse computers for social use provides student engagement with a new perspective on sustainability and social justice while at the same time having an impact on society.

Concern about methods with which to incorporate ESD in university curricula is widespread. Much attention is focused on the "what" and "how" of such a strategy, in terms of the structure, techniques, tools, and competencies needed for ESD in different disciplines. In this sense, Acosta and colleagues [11] start from a systematic review of the literature on the inclusion of ESD in environmental engineering, which allowed the different research questions posed to be answered. The identification of success stories and shortcomings provides information on how to promote sustainability in undergraduate environmental engineering programs.

At the University of Limerick in Ireland, Hogan and O'Flaherty [3] explored the capacity of science for ESD integration as an academic discipline in an undergraduate science education program. Through semi-structured interviews with trainers, focus groups with trainee teachers, and field observations, they concluded that the need exists to improve the scientific literacy of trainee teachers and that the development of a separate Science in Society module is a good option for this undertaking.

In line with the above, the paper by Busquets and colleagues [14] presents results on the concerns of university faculty about the practical integration of ESD in the Spanish higher education system. Specifically, the research aimed to shed light on the faculty's conceptions and competency on sustainability, as well as on the teaching strategies they put into practice. In accordance with the discourse analysis conducted on the focus groups, the results demonstrated that the environmental dimension of sustainability is overemphasized, while the holistic dimension is poorly addressed by faculty, who lack awareness and training in this dimension. Service-learning (in particular) and project-based learning appear as the most effective strategies. However, the authors state that establishing sustainability at the institutional level is not yet a sound strategy.

In order to tackle this issue, different research groups recently introduced generic competencies for sustainability in higher education, in order to move towards the training of professionals with reflective and critical thinking.

In his work, Gimenez-Carbo [10] presents a study on the development of the cross-curricular learning outcome "Ethical, environmental and professional responsibility" by students of different undergraduate degrees at the Universitat Politècnica de València (UPV). The aim of this work was to assess whether students achieve the expected results. The analysis of the programs of the different subjects, the interviews with the professors, and the group meetings with the students helped in the identification of some barriers and difficulties that prevent the effective deployment of the institutional project at the UPV.

On the other hand, several papers presented in this Special Issue used or relied on the map of generic competencies in sustainability (Sustainability competencies map-SCM) designed in the framework of the EDINSOST project. One of the purposes of the map is to examine the presence in university curricula of the four competencies in sustainability proposed by the Sectorial Commission of the Conference of Rectors of Spanish Universities (CRUE). The SCM contains the sustainability learning outcomes that all students should have acquired by the end of their higher studies.

Pino and colleagues [13], from the area of Didactics of Mathematics of the Faculty of Education Sciences of the University of Cadiz, examined the competencies in sustainability in three curricula by performing a content analysis of the programs of the degree courses. Two instruments were used; an adaptation of the Green Curriculum in Higher Education model and the SCM. A very low relative prevalence of the CRUE sustainability competencies (25%) in the area was revealed. Moreover, the competencies were mostly established at the lowest level of competency acquisition, "to know".

The work conducted by Molera and colleagues [23], at the Faculty of Economics and Business of the University of Murcia (UMU), presents the incorporation of sustainability in the Economics Degree through the development of the SCM. Open educational resources were developed to allow students to acquire the competencies of the SCM. The authors' objective was to extend this work to the rest of the faculty's degrees.

The SCM was subsequently enriched in the EDINSOST2-SDG project by linking the learning outcomes of the SCM with the learning objectives of the SDGs, defined by UNESCO. Within the EDINSOST2-SDG project, two working groups from the UMU and the Universitat Internacional de Catalunya (UIC) cooperated in the Business Administration and Management area. Gil-Domenech and colleagues [22], in their paper, presented the SCM for Business Administration and Management (BAM) disciplines, which provides 58 learning outcomes. The work was reinforced by a qualitative analysis of some companies' perceptions about the BAM SCM, which emphasize its value as a tool for sustainability education in this field.

In the field of engineering, three spanish universities cooperated in the EDINSOST2-SDG project, namely Universitat Politècnica de Catalunya (UPC-BarcelonaTech), Universidad del País Vasco UPV-EHU and Universidad Politécnica de Madrid (UPM). Sanchez-Carracedo and colleagues [21] presented three tools for integrating and evaluating ESD in engineering curricula. The first tool, the Engineering Sustainability Map (an SCM for engineering degrees), facilitates the definition and distribution of ESD-related learning outcomes within the curriculum. The second tool, the questionnaire for teachers, helps in the evaluation of the presence of sustainability in the degree, according to the sustainability learning outcomes developed in their subjects. The last tool is a questionnaire that permits the quantitative measuring of the students' perception about their own sustainability learning. The sustainability presence maps and the student questionnaire can help to gauge the extent to which a curriculum effectively achieves its ESD objectives.

In line with these latter results, addressing the progress of sustainability learning entails the determination of the knowledge, awareness and even the habits that students possess on commencing university studies in sustainability. Two papers share this concern.

Manresa and colleagues [16], members of the aforementioned UMU-UIC working group, presented in an additional work an instrument to assess the domain level of sustainability competencies with which students begin university studies. In the specific case of business-related studies, the results revealed a highly heterogeneous freshmen level of development of sustainability competencies. Furthermore, the paper presented by Oberrauch and colleagues [19] explored the relationship between students' conceptions, behaviors, perceived self-efficacy, etc., regarding sustainability. In this case, the authors compared those students starting a teaching degree with students from other degrees at two Tyrolean universities. The authors concluded that the assumption of the concept of sustainability as a guiding principle that can provide orientation in their respective professional fields can

"make a difference" in this degree program, which is essential for the development of ESD in higher education.

Three other papers asked students about the effect of their ESD learning experience on their future performance as agents of change for sustainability. At the Bilbao School of Engineering, Aginako and Guraya [15] interviewed students about their perception of the level of inclusion of sustainability in their studies, as well as the importance they allot to the different dimensions of sustainability. The questionnaire presented in the paper investigated students' activity beyond their knowledge. The authors proposed that an activity-based approach is more in line with ESD genuine interest in transformative outcomes. The results indicated that sustainability is scarcely embedded in the three engineering programs analyzed, although students expressed a keen interest in all of their academic, personal and professional domains.

On the other hand, the work conducted by Martínez-Ventura and colleagues [18] at the Universitat Politècnica de València proposed a questionnaire to determine the extent to which future architects are trained to practice in accordance with sustainable development and how their learning experience contributes to the acquisition of ESD learning outcomes.

Finally, the work conducted by Burkšaitienė and colleagues [17] established an interesting relationship between the situation arising in university learning due to the COVID19 pandemic and sustainable learning. The study was conducted by means of a questionnaire distributed to students belonging to four Lithuanian universities during the last two years of their undergraduate studies (technological, social and humanities). The authors stated that the significant level of stress as a result of the pandemic impaired students' self-direction, which in turn had a negative impact on sustainability learning. They recognized that sustainability learning is self-directed, since it is a transformative experience that requires great effort, flexibility, and involvement by students.

Thus, in order to progress further, and with the aim of contributing to students' sustainability learning, two research groups at UPC-BarcelonaTech presented two activities as effective learning tools for acquiring knowledge and developing competencies in sustainability and social commitment in undergraduate and master's engineering studies. The first was a debate activity that also developed critical thinking skills. In their paper, Rodríguez-Dono and Hernández-Fernández [2] proposed a methodology for the organization of the debate and presented its practical application in the classroom. Finally, the authors included an evaluation procedure through pre/post tests that provides feedback to assess the effectiveness of the debate in the learning process.

Casañ and colleagues [1] presented the second learning tool, an activity based on the PESTLE methodology, which was applied in the classroom with good results and employed the Jigsaw collaborative learning technique. The PESTLE methodology was used to analyze the political, economic, social, technological, legal and environmental aspects of a technology or innovation, thus bringing an ethical dimension to collaborative learning.

As in the professional development of future engineers, an experiential and person-centered approach allowed the authors of the following paper to train engineering students in soft skills, namely responsible engineering, ethics and social commitment. The design of the subject "Personal and Professional Effectiveness" was based on Covey's classic book *The 7 Habits of Highly Effective People* [24]. This paper, proposed by Rodríguez-Jiménez and colleagues [9], provided a detailed description of the activities carried out during the course and analyzed the students' perceptions. They reflected on how the recognition of students' strengths and difficulties influences the development of an engineering work group for sustainability.

At present, universities are expected to work within the framework of the SDGs. In this regard, at the University of Iceland, the purpose of Pálsdóttir and Jóhannsdóttir's research [12] was to provide an overview of the integration of the UN SDGs into the curriculum of their five schools and an overview of the individual SDGs for the university, the aim of which was to identify key challenges and opportunities for improvement. The research was conducted on the basis of the guidelines developed by the UN Sustainable

Development Solutions Network to support universities in implementing the SDGs, organized into the following three phases: Recognition, Opportunities, and Organizational Principle. Based on these guidelines, the researchers conducted an analysis of the descriptions and learning outcomes of all university courses in 2019 and 2020. The results indicate a significant opportunity for improvement, which implies a greater focus on the SDGs in both course descriptions and learning outcomes.

On page 5 of the paper it is stated that "each case [university] is, in effect, a 'living laboratory', positioning sustainability as an intentional and aspirational strategy, with sustainable development and the SDG framework being a means to that end". In the interesting case of the Universidad de Valencia, described in the paper of Vázquez-Verdera and colleagues [6], the SDG integration strategy to position sustainability on campus consisted of the preparation of an online event called "The United Nations we want". This event was organized in collaboration with the Geospatial, Information and Telecommunication Technologies Service of the UN Support Base in Valencia. The authors described the interdisciplinary and collaborative process that took place between professionals and students and professors from different disciplines (scientific, technological, social, legal, human and health), in which they jointly reflected on how to address the challenges of Artificial Intelligence societies and technologies used to drive transformations for sustainability.

The university also offers the opportunity to contribute to change towards sustainability as an active member of society. In their paper, Gomera and colleagues [8] presented their "Trefoil Program", which since 2013 has been designed and implemented by the Environmental Protection Office (SEPA) of the Universidad de Córdoba. Nearly 600 members of the university have so far participated in an ongoing system of participatory certification of "good practices" through which the university achieved improvements in environmental performance over a wide range of areas.

This Special Issue presents no less than 20 research papers from different working groups and universities around the world. They all share the goal of implementing ESD and the SDGs in higher education and universities. The methodologies, strategies, approaches and levels of depth are diverse, but together they provide a broad overview of the efforts already underway. They range from subject-specific activities to mapping learning outcomes in the curriculum in order to improve sustainability integration. They include precise strategies for understanding student learning and perceptions, and on- and off-campus strategies in which university staff, students and practitioners are engaged. Different disciplines are involved, such as engineering, education, economics, the environment, etc. These efforts bode well for a successful journey towards the implementation of ESD in higher education.

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