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Improving Engineering Educators' Sustainability Competencies by using Competency Maps. The EDINSOST Project*

FERMÍN SÁNCHEZ CARRACEDO[1], JORDI SEGALÀS[2], EVA VIDAL[3], CARME MARTIN[1], JOAN CLIMENT[1], DAVID LÓPEZ[1] and JOSE CABRÉ[1]

[1] Barcelona School of Informatics (FIB). Universitat Politècnica de Catalunya (UPC-BarcelonaTech), Spain.
E-mail: fermin@ac.upc.edu, martin@essi.upc.edu, juan.climent@upc.edu, david@ac.upc.edu, jose.cabre@upc.edu

[2] Research Institute for Sustainability Science and Technology. Universitat Politècnica de Catalunya (UPC-BarcelonaTech), Spain.
E-mail: jordi.segalas@upc.edu

[3] Barcelona School of Telecommunications Engineering (ETSETB). Universitat Politècnica de Catalunya (UPC-BarcelonaTech), Spain.
E-mail: eva.vidal@upc.edu

EDINSOST is a project aimed at tackling the challenges facing society. It is funded by the Spanish R&D+i Program. The objective of the project is to establish a framework to facilitate the training of graduates capable of leading the resolution of challenges in our society through the integration of sustainability training in the Spanish University System. For the training of graduates, it is essential to train teachers beforehand, since most of them do not possess competencies in sustainability. The EDINSOST project involves fifty-five researchers from ten Spanish Universities. It encompasses five engineering degrees and three degrees related to the three dimensions of sustainability, given their great impact on the short-term challenges confronting society. In view of its multiplier and long-term effect, the project also includes the Bachelor and Master's degrees of five Education degrees, because graduates from these courses will be the future teachers of new generations of citizens. To achieve its objectives, the project has defined a sustainability competency map for thirteen degrees in the fields of education and engineering. On the basis of this map, the most appropriate didactic strategies for sustainability training will be established, the state of the sustainability training requirements in teachers and students will be diagnosed, and finally, proposals will be made for training both groups. In this paper, the objectives of the EDINSOST project are presented, as well as some results of the first objective: the sustainability competency map for engineering degrees. The map is vital for defining the training needs of teachers and students and is easily adaptable to any engineering degree.

Keywords: training and assessment of educators; education for sustainable development; sustainability in higher education; sustainability competency map; faculty training, teachers training

1. Introduction and background

Contemporary society faces global challenges such as the economic crisis, climate change, desertification, deforestation, inequalities, wars and the eradication of poverty. In this global context, the promotion of Sustainable Development has gained broad international recognition as the way forward to ensure the quality of life, equity between present and future generations and environmental health [1, 2].

Although the conceptualization of Sustainable Development remains controversial, a global consensus exists about the need to raise awareness and develop strategies and action plans to address the global challenges facing society today [1]. Addressing this challenge implies the need to establish action frameworks that facilitate an education for the participation, awareness and training of citizens.

As an institution dedicated to the creation and transmission of knowledge through research and teaching, the university plays a leading role in the dissemination and application of possible solutions and alternatives to the socio-environmental problems posed by society today [1, 3]. The integration of Education for Sustainable Development (ESD) into Higher Education contributes to the development of skills related to the sustainability of university graduates, such as critical and creative thinking, problem solving, capacity for action, collaborative capacity and systemic thinking. This development will allow us to form potential agents of change, capable of shaping a more sustainable society.

Many universities have signed international declarations committing them to introduce Sustainable Development into their educational policy, including curriculum, research and social projection [4]. However, recent studies reveal the lack of social commitment in graduates, as well as how social commitment decreases as students progress through university [5, 6].

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In the Spanish context, in 2005 the Sectoral Commission on Sustainability of CRUE[1] (SCS) approved the document "Guidelines for the Introduction of Sustainability in the Curriculum" (updated in 2012). This text proposes general criteria and recommended actions for curricular sustainability. This process implies a change in the curricula that enables students to acquire (transversal) competencies related to sustainability [7]. Sustainability is defined as a "concept that includes the pursuit of environmental quality, social justice and a fair and viable economy in the long term" [7]. Independently of their area of knowledge, teachers have difficulty in understanding the concept of "curriculum sustainability" and its integration into the different subjects, since this integration requires a transdisciplinary and innovative practice [8, 9]. Recent studies show the efforts made to implement Sustainability in Higher Education, but it is a research area and an emergent action limited by the lack of common criteria about the competencies to be integrated, as well as their promotion and evaluation in university degree courses [10–14]. As an emerging field of research, ESD has focused mainly on the following aspects [4, 15, 16]:

- Environmental management at the university;
- Descriptive case studies and examples of good practices at universities;
- Integration of sustainability into specific areas such as environmental sciences or geography;
- Theoretical developments in teaching and learning focused on sustainability;
- Analysis of university policies.

Curricular sustainability involves the empowerment of the university community and the creation of spaces for reflection and collective collaboration, both inter- and trans-disciplinary, that foster learning, critical reflection on existing practices and worldviews, and creative and innovative action. It is therefore vital to consider joint and coordinated work between different research teams and institutions.

In order to train future engineers in sustainability, it is necessary to provide proper faculty training. Aware of the new competencies that engineers should master, the Universitat Politècnica de Catalunya (UPC-BarcelonaTech) is leading the EDINSOST (Education and Social Innovation for Sustainability) project, the main goal of which is to contribute towards training graduates capable of leading the management of the sustainability challenges facing society by embedding sustainability competencies into the Spanish Higher Education System. This project is financed by the Spanish Ministry of Economy, Industry and Competitiveness and involves fifty-five researchers from ten Spanish universities. It encompasses five engineering degrees and three degrees related to the three dimensions of sustainability, given their great impact on the short-term challenges confronting society. In view of its multiplier and long-term effect, the project also includes the Bachelor and Master's degrees of five Education degrees, since graduates from these courses will be the future teachers of new generations of citizens.

The main objectives of the EDINSOST project are the integration of sustainability into the curriculum, the design of teaching and learning strategies for its implementation in the Spanish university context, and the evaluation of the sustainability competency level of current graduates in the Spanish university system. Faculty training in sustainability is essential for the achievement of these objectives. The first step in such training is to define clearly and accurately the sustainability learning outcomes of each Degree. These results, for engineering degrees, are precisely defined in the Sustainability Competency Map of the engineering degrees presented in this paper.

The rest of the paper is organized as follows: Section 2 reviews the literature on ESD; Section 3 provides an outline of the EDINSOST project; Section 4 presents the results of objective 1 of the project, the creation of the Sustainability Competency Map of engineering degrees; Section 5 describes the future work, and Section 6 concludes the paper.

2. Previous work

Engineering Education in Europe has a long tradition of dealing with environmental problems. The treatment of effluent, municipal solid waste disposal and energy efficiency have a long tradition in various engineering schools. However, these issues have rarely been addressed in terms of the ecosystem, but rather from the technological perspective of the required equipment.

The rise of environmental awareness in the seventies and the social upheaval of those years affected engineering schools in some respects [17]. Environmental and energy issues were included in some curricula, especially Civil Engineering, Architecture and Chemical Engineering.

Nevertheless, environmental issues only marginally affected most of the other engineering curricula. A second wave of environmental awareness was triggered by the Brundtland report [18]. While this renewed interest in environmental issues resulted in

[1] CRUE refers to the Conference of Presidents of Spanish Universities.

new initiatives, sustainability ethics still needs to form part of institutional culture [19].

In the past decade, much insight has been gained into the task that lies ahead. With hindsight, one might say that the approaches taken to the introduction of sustainability into engineering education in the 1990s were somewhat naïve: Developing an add-on course, teaching other teachers about Sustainable Development and creating a track for Sustainable Development specialists are at best just the first step.

The next steps to be taken in ESD should not only concern what course should be added to make engineering more sustainable in an always "crowded" curriculum, but also addressing the question of what type of curriculum might contribute effectively to Sustainable Development, as well as motivating students and faculty to improve their sustainability competencies. Instead of adapting an unsustainable curriculum or introducing Sustainable Development, curricula should be rebuilt by benefitting from ESD expertise as the leading principle for curricula. This will not happen if faculty members are not equipped for the task. Dealing with Sustainable Development and social models helps faculty to propose actions for improving the methodology and thereby enhancing students' competencies [20]. The full integration of Sustainable Development into a subject requires both sustainability content as well as suitable learning strategies. A focus on how we teach as much as what we teach is important if we are to educate for Sustainable Development. Moreover, active learning strategies are necessary for creating the integrated and inter- and trans-disciplinary perspective required for sustainability education [21]. A set of guiding principles for the design of innovative active learning experiences may be drawn from the results of the Experiencing i-Design project described in [22].

Sustainability issues are widely recognized as wicked problems [23], which should not be regarded as problems to be solved, but rather as conditions to be managed. A general agreement exists about the need to reform the scientific expertise required to deal with sustainability challenges by developing new ways of knowledge production and decision-making. In that sense, Stephen Sterling [24] maintains that the nature of sustainability requires a fundamental change in epistemology, and therefore in education. As regards technological education, the Barcelona Declaration [25], approved during the Engineering Education in Sustainable Development Conference in 2004, states that today's engineers must be able to:

- Understand how their work interacts with society and the environment, locally and globally, in order to identify potential challenges, risks and impacts.
- Understand the contribution of their work in different cultural, social and political contexts, and consider these differences.
- Work in multidisciplinary teams in order to adapt current technology to the demands imposed by sustainable lifestyles, resource efficiency, pollution prevention, and waste management.
- Apply a holistic and systemic approach to solving problems and have the ability to move beyond the tradition of breaking reality down into disconnected parts.
- Participate actively in the discussion and definition of economic, social and technological policies in order to help redirect society towards more Sustainable Development.
- Apply professional knowledge according to deontological principles and universal values and ethics.
- Listen closely to the demands of citizens and other stakeholders and let them have a say in the development of new technologies and infrastructures.

3. The EDINSOST project

EDINSOST is the acronym for the project "Education and social innovation for sustainability. The training in Spanish Universities of professionals as agents of change to face the challenges of society". The project is funded by the "Spanish Program for R&D+i Facing the Challenges of Society" over the period January 2016 to December 2018.

Given the current state of ESD in the Spanish university system, the project considers the necessity to promote a cultural change towards sustainability for the integration of curricular sustainability into degree courses in Spanish universities. To this end, the following aspects should be taken into account:

- The introduction of sustainability as a competency for working on a set of specific subjects in each degree. This set of subjects will constitute a sustainability itinerary to enable graduates to incorporate ESD into their field of specialization.
- The introduction into the curriculum of special subjects devoted to sustainability. These subjects will also be part of the sustainability itinerary.
- The development of interdisciplinary and multidisciplinary projects in which sustainability is addressed together with the specific competencies of each degree.
- The introduction of ESD into the training processes in all degrees.
- Advancing pedagogical innovation and the development of didactic materials to facilitate the sustainability training of students and teachers.

- Training students and teachers in sustainability.
- Defining competency-based standards and profiles in ESD.

Thirteen degree courses in the fields of education and engineering are involved in the project. These degrees are taught in ten Spanish Universities (Universidad Autónoma de Madrid -UAM-, Universidad de Cádiz -UCA-, Universidad Camilo José Cela -UCJC-, Universidad de Córdoba -UCO-, Universitat de Girona -UdG-, Universitat Internacional de Catalunya -UIC-, Universitat Politècnica de Catalunya-Barcelona Tech -UPC-, Universidad Politécnica de Madrid -UPM-, Universidad de Sevilla -US- and Universidad de Salamanca -USAL-). Fifty-five researchers belonging to the research team and the work team are engaged in the project. The ten universities work on sustainability within the framework of the SCS and in collaboration with other universities.

The EDINSOST research methodology adopts an interpretive approach employing both quantitative and qualitative techniques. The work is carried out in different degree courses at three levels of incidence:

- Five Bachelor engineering degrees with significant implication in short-term social challenges: the Bachelor degrees in Mechanical Engineering, Design Engineering, Electrical Engineering, Informatics Engineering and Chemical Engineering.
- Three degrees related to the three dimensions of sustainability (environmental, social and economic): the Bachelor degree in Environmental Sciences, the Master degree in Science and Technologies of Sustainability and the Bachelor degree in Administration and Business Management.
- Finally, and in view of their multiplier and long-term effect, the project is working on five Bachelor or Master in education courses, given that such graduates will be the future teachers of the new generations of citizens: Bachelor degree in Early Childhood Education, Bachelor degree in Primary Education, Bachelor degree in Pedagogy, Bachelor degree in Social Education, Master degree in Secondary Teacher Training and Inter University Master Degree in Environmental Education.

The EDINSOST project has the following four specific objectives:

- Objective 1 (O1): To define the Sustainability Competency Map of each of the participating degrees and establish a framework for incorporating the map into the degree in a holistic way;
- Objective 2 (O2): To validate different didactic strategies for addressing sustainability from a constructivist and community pedagogical approach;
- Objective 3 (O3): To diagnose the status of the training needs, in terms of sustainability, of the teachers of each degree, as well as to develop and test training proposals;
- Objective 4 (O4): To diagnose the sustainability competency level of current university students and to develop and test training proposals.

The scope of this paper is limited to some results of objective O1. However, objectives O2, O3 and O4 use the Sustainability Competency Map, developed in objective O1, as a starting point. The questionnaires corresponding to the O2, O3 and O4 objectives have been designed and validated during the first half of year 2017. At the beginning of the 2017–2018 course, some thirty questionnaires of the O4 objective have been passed in subjects from different universities and degrees. These questionnaires have been passed again at the end of the semester to analyze the evolution of the competencies in sustainability of students in each of the surveyed subjects. The O4 questionnaires are been surveyed in first months of 2018 to analyze the students' level in sustainability competencies of entry and exit at each of the degrees studied in the project. The questionnaires corresponding to the O2 and O3 objectives are also been surveyed in first months of 2018.

The results generated by the project will be transferred to other universities nationally through the SCS, and to other universities internationally through its diffusion and transferability plan. An ESD observatory will be established to carry out this dissemination.

4. The sustainability competency map of engineering degrees

In order to integrate ESD into the Spanish university system, the EDINSOST project considered it essential to develop a Sustainability Competency Map suitable for all the degrees involved in the project. This map should be generic (sustainability is a transversal competency) and easily exportable to different Degrees. The maps of the Degrees involved in the project should therefore all resemble each other closely. This would provide a map that is not only simple and transversal, but also facilitate its adaptation to other degrees not included in the project.

Members of both the SCS and the SeeCS [26] group at the Barcelona School of Informatics (Sustainability, Education and Ethics in Computing and Services) work together on the EDINSOST Project.

The SeeCS group has been developing strategies for inclusion of sustainability in the Bachelor Degree in Informatics Engineering for years. Given that the SCS has been working on specific ESD-related competencies requiring development at all levels, and that the SeeCS group has experience in developing the Sustainability Competency Map, it was regarded as appropriate for the project that this accumulated experience be shared. Each group drew up its own proposals and instruments, and as a starting point, the participants decided that both proposals should be merged.

On the one hand, SCS identified four sustainability-related competencies to be developed for inclusion of the ESD in the curriculum.

- C1: Critical contextualization of knowledge by establishing interrelations with social, economic, environmental, local and / or global problems.
- C2: Sustainable use of resources and prevention of negative impacts on the natural and social environment.
- C3: Participation in community processes that promote sustainability.
- C4: Application of ethical principles related to the values of sustainability in personal and professional behavior.

On the other hand, the SeeCS group designed a Sustainability Competency Map for the Bachelor Degree in Informatics Engineering [27]. The map is a double entry table: the three dimensions of sustainability (economic, social and environmental), plus a holistic dimension, are included in its rows. Each dimension is subdivided into one or more competency units (specific aspects to be treated within each sustainability dimension). The learning outcomes related to each competency unit, classified according to three domain levels, also figure in the columns. To define domain levels, the three lowest levels of the Bloom taxonomy (knowledge, understanding and application) were initially used by the SeeCS group [28].

In order to integrate all these instruments into a single proposal, a matrix based on the competency maps presented at the Frontiers in Education Conference [29] was created. Matrix's rows are defined from the four competencies related to sustainability stated by the SCS (C1–C4). Each competency has been studied from the perspective of the three dimensions of sustainability and from the holistic point of view, and one or more competency units (sub-competencies) have been defined for each sustainability dimension. The competency units would take into account the work presented in [27, 30, 31], plus the work derived from the SCS.

In previous work by the SeeCS group, the three lowest levels of Bloom's taxonomy were employed as domain levels. Given that the three highest levels of Bloom's taxonomy were not defined in this work (analysis, synthesis and evaluation), the EDINSOST project uses as taxonomy a simplified version of the Miller Pyramid [32, 33] to define the domain levels. This option enables the Sustainability Competency Map to be defined by using all the domain levels of the taxonomy. The Miller Pyramid defines four levels of competency: Know, Know How, Demonstrate and Do. To unify them in three levels, the Demonstrate and Do levels have been combined at a single level of competency, given the subtle difference they present in many cases.

The first problem to overcome was the excessive theoretical size of the Sustainability Competency Map. Four competencies (C1–C4), with four dimensions (environmental, economic, social and holistic), each defined with three domain levels, led to a map of 48 cells even then only one competency unit is defined for each dimension. With so many cells, the map is too large and complex to be implemented effectively and efficiently in any Degree.

It is necessary to point out that each learning outcome could be developed in one or more subjects, with the aim of ensuring that all the learning outcomes defined in the domain levels are developed at least in one subject. For this reason, it was necessary to simplify the map, since sustainability must be developed as a transversal competency, and a map with so many cells would require a high consumption of the Degree resources. Thus, since it seemed unnecessary for all competencies to be developed in the four dimensions, the most relevant dimensions for each competency were analyzed.

A decision was then taken about which competency units should be developed in each degree in order to seek convergence towards a single map for all the degrees in the project. Because of the different nature of these degrees, it was not possible to find a group of competency units common to all. However, two groups of competency units were established: the first one for education-related degrees and the second one for other degrees (including all Engineering degrees). The set of competency units selected for education-related degrees only takes into account the holistic dimension for each competency, and it is out of the scope of this work. Table 1 shows the competency units selected for the Sustainability Competency Map of Engineering Degrees.

As seen in Table 1, competency C2 is the only one that deals independently with the three dimensions of sustainability: economic, social and environmental, plus the holistic point of view. The remaining competencies deal only with sustainability in a holistic way. The complete Sustainability Competency Map drawn up for Engineering Degrees can

Table 1. Competency units selected for the Sustainability Competency Map of Engineering Degrees

SUSTAINABILITY COMPETENCY MAP of an Engineering Degree		
Competencies related to sustainability	**Dimensions**	**Competency unit**
C1: Critical contextualization of knowledge establishing interrelations with social, economic and environmental, local and / or global problems.	Holistic	Has a historical perspective (state of the art) and understands social, economic and environmental problems, both locally and globally.
		Is creative and innovative. Is able to see the opportunities offered by the Engineering to contribute to the development of more sustainable products and processes.
C2: Sustainable use of resources and prevention of negative impacts on the natural and social environment.	Holistic	Takes into account sustainability in his / her work as an engineer.
	Environmental	Takes into account the environmental impact of his / her work as an engineer.
	Social	Takes into account the social impact of his / her work as an engineer.
	Economic	Is capable of successfully carrying out the economic management of an Engineering project.
C3: Participation in community processes that promote sustainability.	Holistic	Identifies when the sustainability of a project can be improved if it is conducted through community collaborative work. Performs responsibly collaborative work related to sustainability.
C4: Application of ethical principles related to the values of sustainability in personal and professional behavior.	Holistic	Behaves according to the deontological principles related to sustainability.

be found in Table 2. This map shows the definition of learning outcomes at three domain levels for each of the competency units.

The Sustainability Competency Map of engineering Degrees defines the learning outcomes in sustainability for students on conclusion of their studies. Subjects must set realistic goals to achieve these learning outcomes, and these objectives must be developed in different subjects for the entire map to be covered. One of the greatest challenges to the achievement of the objective O1 is the lack of adequate training for teachers in sustainability. The Sustainability Competency Map helps to correct this problem, since it clearly defines the aspects in which teachers must be trained. Objective O3 of the project is aimed at identifying these teacher-training needs. Furthermore, teachers also need help in using the most appropriate educational strategies to achieve the learning outcomes. The purpose of objective O2 is to define those strategies. The objectives O3 and O4 are just focused on developing training proposals for teachers and students, including the corresponding rubrics for competences' assessment. On the EDINSOST project, experts on pedagogy are discussing about the final format of the assessment of the learning outcomes. One of the possibilities, which is on the ongoing work, is measuring the different learning outcomes through a four-level Likert-type scale, from "not knowledge at all" to "expertise knowledge".

With regard to objective O1, one of the most important results is that the Sustainability Competency Maps developed may easily be adapted to any degree in the university system. This observation may be verified by the fact that the five Engineering degrees involved in the project (Mechanics, Design, Electrical, Informatics and Chemistry), as well as the Bachelor Degrees in Environmental Sciences and Administration and Business Management, make up a map based on the one presented in this paper (with very few differences between them, except those related to the specificity of each degree).

For example, the first of the learning outcomes of level 1 (Know) of the holistic dimension of competence C2 states: "Knows the concept of cost of use, direct and indirect, of the products and services of the technologies related to the Engineering" can easily be adapted to chemical qualifications such as "Knows the concept of cost of use, direct and indirect, of the products and services of the technologies related to the Chemical Engineering".

Furthermore, the five degree courses related to education are brought together in a single Sustainability Map for all of them. The Sustainability Competency Map for education degrees contains only the holistic dimension for each Competency Unit. This is because the aim of the educational degrees is to ensure that both faculty and students acquire a holistic view of sustainability, while in the case of the engineering degrees a special vision for the competency C2 was applied. This is because

Table 2. Sustainability Competency Map for Engineering Degrees. Competencies are represented by their numbering (C1–C4) under the heading C, and the sustainability dimensions by their initial letters (EN—Environmental, S—Social, EC—Economic and H—Holistic) under the heading D

SUSTAINABILITY COMPETENCY MAP of an Engineering Degree

C	D	Competency unit	Domain levels (according to simplified Miller Pyramid)		
			1. KNOW	**2. KNOW HOW**	**3. DEMONSTRATED + DO**
C1	H	Has a historical perspective (state of the art) and understands social, economic and environmental problems, both locally and globally.	Knows the main causes, consequences and solutions proposed in the literature regarding the social, economic and/or environmental problems, both locally and globally.	Analyzes the different dimensions of sustainability when solving a specific problem related to the Engineering.	Identifies the main causes and consequences of a problem related to the sustainability that a product or a service related to the Engineering can have, and is able to relate them to known problems and solutions previously applied.
		Is creative and innovative. Is able to see the opportunities offered by the Engineering to contribute to the development of more sustainable products and processes.	Has sufficient knowledge of the concepts of creativity and innovation, and about strategies to develop them.	Reflects on new ways of doing things. Knows how to use techniques that stimulate creativity, the generation of ideas, and manages them in such a way that they become an innovation. Participates actively when used.	Brings new ideas and solutions to a project related to the Engineering to make it more sustainable, so as to improve the sustainability of products, processes or services.
C2	H	Takes into account sustainability in his/her work as an engineer.	Knows the concept of cost of use, direct and indirect, of the products and services of the technologies related to the Engineering. Knows the strategic role that the technologies related with the Engineering play in the sustainability of the planet. Knows the concepts of social justice, resource reuse and circular economy. Knows the concept of social economy, the advantages of solidarity, teamwork and cooperation versus competition. Knows the principles of the economy for the common good.	Is capable of assessing the impact (positive and negative) that different products and services related to the Engineering have in society and in the sustainability of the planet. Knows how to assess the economic viability of a project of the Engineering and whether it is compatible with the environmental and social aspects of sustainability.	Is capable of proposing sustainable projects related to the Engineering taking into account, holistically, the environmental, economic and social aspects.
	EN	Takes into account the environmental impact of his/her work as an engineer.	Knows technologies of reuse, reduction, recycling and minimization of the natural resources and residues related to a project of the Engineering. Knows the life cycle of the products related to the Engineering (construction, use and destruction/dismantling) and the concept of ecological footprint. Knows models for ecological footprint calculation. Knows metrics to measure the environmental impact of a project (eg. pollutant emissions, resource consumption, etc.).	Is aware that products and services related to the Engineering have an environmental impact throughout its life. Is capable of measuring the environmental impact of the use of technologies related to the Engineering using appropriate metrics (eg. pollutant emissions, resource consumption, etc.).	Takes into account the environmental effects of the products and services related to the Engineering in the projects and technological solutions in which he/she participates. Includes in his/her projects indicators to estimate/measure these effects from the resources used by the project (eg. energy consumption, pollutant emissions, consumption of resources, etc.). Calculates the ecological footprint of an Engineering project.

Table 2. (*cont.*)

SUSTAINABILITY COMPETENCY MAP of an Engineering Degree

C	**D**	**Competency unit**	**Domain levels (according to simplified Miller Pyramid)**		
			1. KNOW	**2. KNOW HOW**	**3. DEMONSTRATED + DO**
C2 (*cont.*)	S	Takes into account the social impact of his/her work as an engineer.	Knows the problems associated with accessibility, ergonomics and safety of products and projects of the Engineering. Knows the problems associated with social justice, equity, diversity and transparency (gender perspective, needs of the most vulnerable groups, strategies against corruption, etc.). Knows the direct and indirect consequences that the products and services related to the Engineering have on the society.	Knows how to assess the degree of accessibility, ergonomic quality, the level of safety and the impact on society of a product or service related to the Engineering. Takes into account the rights of people in their work as an engineer. Understands the need to introduce social justice, equity, diversity, transparency (gender perspective, needs of the most vulnerable groups, anti-corruption, etc.) in projects of the Engineering. Can assess whether an engineering project contributes to improving the common good of society.	Takes into account the aspects of accessibility, ergonomics and security in technological solutions. Takes into account social justice, equity, diversity and transparency (gender perspective, needs of vulnerable groups, combating inequality and corruption, etc.) in his/her projects. Includes in his/her projects indicators to estimate/measure how they improve the common good of society. Is able to maximize the positive impact of his/her professional activity on society. Is capable of designing Engineering projects that contribute to improve the common good of society.
	EC	Is capable of successfully carrying out the economic management of an Engineering project.	Knows basic concepts about organizations. Knows the fundamental points of a business plan. Knows the process of managing a project. Knows project-planning techniques.	Understands the different economic parts of a project: amortizations, fixed costs, variable costs, etc. Analyzes real planning cases and project budgets.	Is able to plan an Engineering project (both short and long term) and to prepare a complete budget based on the material and human resources required. Is able to follow economic development of a project and detect deviations from the initial planning. Is capable of carrying out the economic management of an engineering project throughout its useful life.
C3	H	Identifies when the sustainability of a project can be improved if it is done through community collaborative work. Responsibly performs collaborative work related to sustainability.	Knows the concept of community collaborative work and its implications in the transformation of society. Knows examples of projects that have been successfully implemented with community collaborative work in the field of the Engineering. Knows the tools of collaborative work in the field of the Engineering.	Given a project in the field of the Engineering, that includes a collaborative community work, is able to assess the implications of such work in the sustainability of the project.	Knows how to use collaborative work tools related to Engineering projects.
C4	H	Behaves according to the deontological principles related to sustainability.	Knows the deontological principles related to sustainability. He/she is aware that there are laws and regulations related to sustainability in his/her professional field. Knows the concept of social and corporate responsibility in general, and its possibilities and limitations.	Is able to assess the implications of the deontological principles related to sustainability in a project in the field of the Engineering.	Does not make decisions that contradict the deontological principles related to sustainability. Is capable of proposing solutions and strategies to promote projects in the field of the Engineering, consistent with these principles.

"Sustainable use of resources and prevention of negative impacts on the natural and social environment" is the sustainability competency most directly related to the professional activity of engineering.

The fact that the unification of the thirteen different Degrees involved in the EDINSOST project uses only two models of Sustainability Competency Maps proves their transversality.

5. Future work

As regards objective O1, the next step is to compare the curricula of the degrees analyzed in the project with the competency maps introduced herein. From this diagnosis, suggestions for improvements in each degree curriculum will be made to the Spanish accreditation agencies and CSC.

In order to achieve objectives O2, O3 and O4, the Sustainability Competency Map is being used. The different educational strategies for addressing sustainability, which must therefore be validated in objective O2, are currently being analyzed by considering each of the competency units of the map and each of the learning outcomes. With regard to objectives O3 and O4, a validated questionnaire is being used to diagnose the training needs of both teachers and students. Questionnaires have been designed in accordance to the Sustainability Competency Map. Questionnaires are being surveyed from the second semester of 2017 to the first semester of 2018. As a result of the diagnosis, training action plans and educational resources will be developed for both faculty (objective O3) and students (objective O4).

6. Conclusions

In this paper, the Sustainability Competency Map for engineering degrees, as the initial result of the EDINSOST project, is presented. The map may easily be adapted to any engineering degree. For educational degrees, a further map is proposed in which only the holistic dimension of each competency is addressed.

While a general agreement exists about the importance of sustainability in today's world and given the need to include it as professional competency for university graduates, sustainability is also one of the most difficult competencies to address in engineering studies, especially if it is holistically approached throughout the curriculum. A tool such as the Sustainability Competency Map, that is easily adaptable to any degree, may prove to be of great help for curriculum designers. The Sustainability Competency Map will enable teacher-training needs, as well as the didactic teaching strategies enabling educators to train their students in sustainability, to be defined, thereby providing them with the competencies defined at the 2004 Education in Sustainable Development Conference.

Over the next year and a half, the EDINSOST project will continue working on the O2, O3 and O4 objectives, for which the Sustainability Competency Map obtained in objective O1 is used as a starting point.

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Fermín Sánchez, **Carracedo** received his BSc in computer science in 1987 and his PhD in computer science in 1996 at the Universitat Politècnica de Catalunya (UPC-BarcelonaTech). Since 1987 he has been lecturing at the UPC-BarcelonaTech Department of Computer Architecture, where he has been an Associate Professor since 1997. He was Vice-Dean for Innovation at the Barcelona School of Informatics from May 2007 to June 2013, and since then he has held the position of Deputy Dean for Innovation. Dr. Sánchez's awards include an Honorable Mention in the 1st European award for best practices for the integration of Sustainable Human Development into technology and engineering education (2013), and the AENUI's 2017 Award to the Quality and Innovation in Teaching.

Jordi Segalàs is the Director of the Research Institute of Sustainability Science and Technology at UPC-BarcelonaTech. He is head of the Research Group on Sustainability Education and Technology in Higher Education. He has been the Director of the Catalan Research Network of Education for Sustainability. He obtained his PhD in Sustainability Education in Engineering at UPC-BarcelonaTech.

Eva Vidal received the MS and the PhD Telecommunication Engineering degrees (both with honors) from the UPC-BarcelonaTech. She is currently Associate Professor at the Electronics Engineering Department at the UPC-BarcelonaTech. Her interests include RF and analog circuit design and sustainability and development on the ICT areas. She is the Director of the Center for Development Cooperation of the UPC-BarcelonaTech.

Carme Martín received her BSc and PhD degrees in computer science from the UPC-BarcelonaTech in 1991 and 2005, respectively. She is a member of the Service and Information System Engineering department (ESSI) and the Center for Language and Speech Technologies and Applications (TALP), both of UPC-BarcelonaTech. Her research interests include database systems, temporal databases, databases for natural language processing and engineering and sustainability education.

Joan Climent received his MS and PhD degree in Computer Engineering from the UPC-BarcelonaTech in 1990 and 1997, respectively. He is currently an Associate Professor in the Barcelona School of Informatics at the UPC-BarcelonaTech, teaching Computer Vision and Embedded Systems. His research interests include computer vision, morphological image processing, and sustainability.

David López is Associate Professor at UPC-BarcelonaTech, and currently the Director of the Institute of Education Sciences. He holds a PhD and an MS in Computer Science. His research interests are focused on sustainability, ethics and education in engineering, especially in computing and services.

José Cabré is Associate Professor in the UPC-BarcelonaTech. Degree on Economics from University of Barcelona (1982) and PhD in Business Administration from UPC-BarcelonaTech (1996). Specialized in teaching in the area of Sustainability and Economics. Dr. Cabré's awards include the first academic award for improvement in the quality of teaching at the UPC-BarcelonaTech (1997–98) and an Honorable Mention in the 1st European award for best practices for the integration of Sustainable Human Development (SHD) into technology and engineering education (2013).