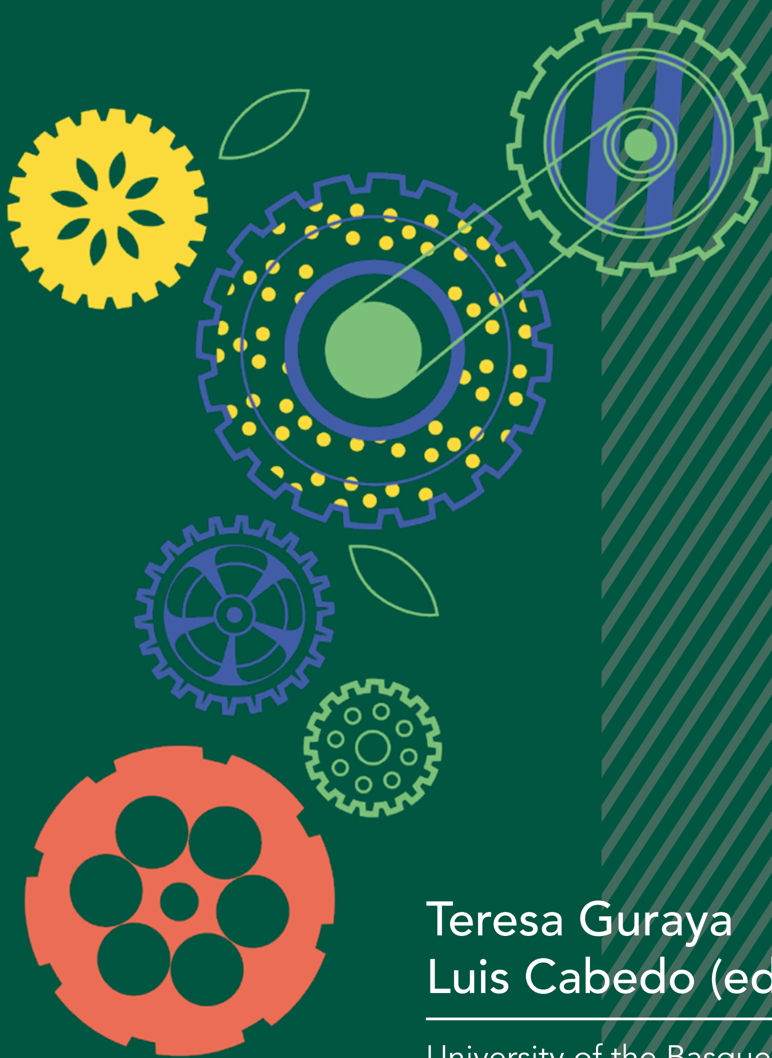
SECOND INTERNATIONAL CONFERENCE ON

ENGINEERING EDUCATION

FOR THE XXI CENTURY

Engineering Education towards Sustainability: Approaches for Institutionalization and Teaching Implementation



Teresa Guraya
Luis Cabedo (eds.)

University of the Basque Country
Bilbao
July 4th - 5th, 2019

eman ta zabal zazu

Universidad del País Vasco / Euskal Herriko Unibertsitatea

UJI UNIVERSITAT JAUME I

Engineering Education towards Sustainability: Approaches for Institutionalization and Teaching Implementation

Second Internacional Conference on Engineering Education for the 21st Century – ICEE21C 2019

Teresa Guraya
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Editorial

On behalf of the organizing committee, we are honored to invite you to the SECOND INTERNATIONAL CONFERENCE ON ENGINEERING EDUCATION FOR THE TWENTY-FIRST CENTURY, to be held in Bilbao (Spain) on 4 and 5 July 2019.

The conference is co-organized by the University of the Basque Country (UPV/EHU) and the Universitat Jaume I in Castelló (UJI) and continues the debate started two years ago in Castelló de la Plana, where the central theme of the conference was "New Competences in the Area of Sustainability and University Social Responsibility". The central theme of this second international conference is "Engineering Education towards Sustainability: Approaches for Institutionalization and Teaching Implementation".

In a world deluged by social realities, change is an absolute necessity. Such change has found its way to European Higher Education Area, affected teaching objectives, pedagogies, and knowledge transmission. With the mission to help learners to create their capability profiles, this change visualizes graduates who can be absorbed easily by ever-evolving industries. To this aim, new active learning methodologies and Information and Communication Technologies (ICT) have been introduced and applied. These changes started to appear in classrooms in the era that also fosters social values such as Sustainable Development Goals and Conscious Social Responsibilities more than ever, striving to build an equitable world.

Education in such a time then becomes a multifaceted and complex phenomenon. Therefore, constant communication and continuous reflection on needs, challenges, and interventions from practitioners, educators, and industry representatives seem necessary. We believe localized and contextualized experiences that shaped by specific academic cultures and education systems equip us better in meeting the urgent demands of this century.

This second conference is structured in six blocks: it will keep the five sessions set in the former edition but preceded by a debate on the sustainability and institutionalization models for the university system:

a) Institutional leadership towards education for sustainability
b) Service-learning and social commitment in engineering
c) Engineering and development co-operation
d) Environmental sustainability
e) Corporate and business social responsibility
f) Engineering and diversity

During the first session of the conference, we invite you all to discover and share the different ongoing approaches in institutionalization of sustainability in university contexts. For so, delegates from national and international academic institutions, who are recognized for their work in the development of programs and strategies to implement sustainability objectives in their institutions, are invited to share their insights. The experts will gather at round tables for presentations, debates, and deliberations about different strategies.

The second part of the conference consists of specific sessions aiming at disclosing the best way to address competencies associated with sustainability. In each session, we will focus on one of the five proposed issues. We will work from strategies of educational innovation applied to engineering studies and listen to colleagues who are implementing different aspects of Social Responsibility and Sustainability in the curricula of graduate and postgraduate engineering studies. The contributions are but not limited to the creation of theoretical frameworks, guidelines for research in engineering education, implementation sustainability objectives in higher education institutions, application of new methodologies in the classroom, presentation of teaching experiences and other activities related to education in engineering.

Each session invites lectures and leading experts from universities and institutions with relevant experience in framing sustainability objectives. The contributions of researchers who already work in this direction are expected to serve as inspiration as well as illustrative examples.

Communications will be in the form of oral presentations, poster presentations, and virtual presentations. Each session will embrace several selected oral and virtual presentations followed by a workshop consisting of poster teaser presentations and debates.

The conference will be live-streamed for whom wish to participate but cannot attend in person.

The organizing committee looks forward to welcoming you all to a fruitful conference with open discussions and important networking to promote high quality education.

On behalf of the organizing committee,

Teresa Guraya Diez (UPV/EHU), co-chair
Luis Cabedo Mas (UJI), co-chair

* The present book is the compilation of the abstracts submitted by the conference delegates as delivered.

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C

Corporate and business social responsibility

C-1

Institutional Relations between the University of Valencia (Spain), the University of Camagüey and the University of Pedagogical Sciences of Havana (Cuba), for the implementation of Service-Learning from the perspective of education for sustainability

M. Pilar Martínez-Agut[1]*, Anna Monzó Martínez[1],
Isidro E. Méndez Santos[2], Roeris González Sibilla[2], Marisela Guerra Salcedo[2],
Daemar Ricardo Marrero[2], Julio C. Rifa Tellez[2], María Victoria González Peña[3],
Maikel Pons Giralt[3], Rafael Bosque Suárez[4], Amparo Osorio Abad[4],
Yaneisys Cisneros Ricardo[4], Jean Robaina Sánchez[4], Lianny Sánchez López[5]

[1] Universitat de València (Proyecto REDUVAPS-Red de Aprendizaje-Servicio de la Universitat de València, UV-SFPIE_GER18-844761)

[2] Universidad de Camagüey "Ignacio Agramonte Loynaz" (Camagüey, Cuba), Centro de Estudios de Gestión Ambiental

[3] Universidad de Camagüey "Ignacio Agramonte Loynaz" (Camagüey, Cuba), Facultad de Ciencias Sociales

[4] Universidad de Ciencias Pedagógicas Enrique José Varona de La Habana (Cuba), Centro de Estudios de Educación Ambiental-Gea

[5] Universidade Federal de Minas Gerais (Belo Horizonte, Brasil)

**mdelpi@uv.es*

Keywords: Sustainable Development Goals SDG, key transversal competences, Service Learning, ApS

Introduction

The Sustainable Development Goals (SDGs) link global needs with participation and education (SDG 4), and through the key transversal competences aim to achieve all the SDGs (UNESCO, 2017); for this, the Learning-Service methodology can be significant (Puig, Batllé, Bosch, and Palos, 2007, Puig, Coord., 2009, Martínez-Agut, 2018). This methodology links learning with service to the community and, therefore, with the need to commit to improving the environment.

As considered in an educational report on Latin America, disseminated by UNICEF, this methodology is adapted to the characteristics of the area, although it does not arise in it, and has had a great expansion in Latin American countries (UNICEF, 2015).

The permanent training of teachers includes the modality of training stays in other universities, which provides both the visiting professor and the institution that receives it, a very positive exchange of different strategies, methodologies, points of view, etc. (Aznar-Minguet, Ull, Martínez-Agut, and Piñero, 2017, Aznar-Minguet, Ull, Piñero, and Martínez-Agut, 2017).

The institutional relationship between the University of Valencia and the University of Camagüey "Ignacio Agramonte Loynaz" (Cuba) begins when it comes to the Department of Education Theory of the Universitat de València in May 2018, a professor at the University of Camagüey (Cuba) to make a training stay. The Learning-Service methodology is striking and interesting to the visiting professor, so there is an interest to introduce it in his University, with the advice of the professors of the University of Valencia in this process.

The exchange between the two Universities continues when a professor from the Universitat de València moves to the Universities of Camagüey and Pedagogical University of Havana, in February 2019.

Results and Discussion

Process description

The Universitat de València, in the section on International Relations, presents a Cooperation unit that deals with the dissemination and management of different scholarship programs (own and from other institutions), training, research, development and awareness projects (UV, 2019).

In May 2018 the Department of Educational Theory of the Universitat de València, a professor from the University of Camagüey (Cuba) attended a training stay, with the call for Young Investigator Scholarships 2018 of the Cooperation Program 0'7 of the Universitat de València, aimed at researchers from developing countries (UV, 2017). From the faculty of the Department is presented different Research Projects in which this faculty participates, including the Research Project of the UV UV-SFPIE_GER17-588199, with the UVAPS Title: Valencian Public Universities by the APS. This methodology is striking and interesting to the visiting professor, so it is presented how it is carried out (Martínez, Coord., 2008, Martínez-Agut, Aznar, Ull, and Piñero, 2007; Ull, Aznar, Martínez, Palacios, and Piñero, 2008).

Within the Research Project on Service-Learning, there are different work groups, the authors of this work being "Education and awareness in schools, adult education and teacher training", responsible for collecting and disseminating experiences , establish relations between the UV and other institutions (such as the Training Center, Innovation and Resources for Teachers -CEFIRE-), disseminate the initiatives carried out in Conferences..., promote the realization of ApS between different university educational stages and non-university, among others.

The exchange between the two Universities continues when a professor of the Universitat de València with the aid of Mobility by Framework Agreement between the Universitat de València and other institutions of Higher Education from foreign countries of development cooperation for the year 2019 (UV, 2018) , moves to the University of Camagüey and the University of Pedagogical Sciences of Havana in February 2019, and a joint work is carried out with the faculty of the Environmental Management Studies Center of Camagüey and with the Center for Environmental Education Studies- Gea, from Havana.

More positive aspects

In this line a collaboration has been initiated, the implementation of Service Learning from sustainability (Martínez-Agut, 2015; 2016; 2017; UNESCO, 2014), in various degrees of the University of Camagüey "Ignacio Agramonte Loynaz", as they are the Master in Environmental Education and the Bachelor in Education in Biology, and in the degrees of the University of Pedagogical Sciences "Enrique José Varona" of Havana (Cuba) as they are, the Master in Geographical Education, and the Bachelor in Education, Geography and Biology, with the support of the working group of the APS Project of the University of Valencia. It is a project that integrates different disciplines that converge in the theme of education for sustainability.

Difficulties and strategies used

In the first place, a formative support is made to the teaching staff, so that:

- A working group is created in the University of Camagüey and in the University of Pedagogical Sciences of Havana, the degrees and subjects where the APS could be started from a Sustainability point of view.
- Indications are given on how to introduce the ApS in the subjects, manage the organization of the classroom and of the students, tutorize the choice of subject and the place of intervention, carry out the accompaniment of the students and the evaluation of the learning and the service.
- A document is proposed to make the report-memory of the ApS.

All these elements will require joint advice, collaboration and learning from the UV team.

Challenges and perspectives

For the realization and implementation of this project different communication, training and contact ways are established: to enhance the training stays of the teaching staff, to carry out joint activities, participation in congresses and seminars, student exchange and mobility, to initiate linked research.... (Cortina, Escámez, García López, LLopis, and Ciurana, 1998; Escámez, 2004; Escámez, 2008).

Contacts are also initiated with the Federal University of Minas Gerais (Belo Horizonte, Brazil) to present this methodology and initiate a joint collaboration from the fields of teaching and research.

Conclusion

The students and the university teaching staff must be linked to their context and their community from education for sustainability, and the Learning-Service methodology presents the possibility of relating the learning from the university curriculum to the service to the community. Training from the university needs to be linked to meaningful learning, linked to the reality of the student body and with an ethical orientation. Even more in those degrees linked to sustainability and education. Learning-Service is, in this sense, an ideal methodology to work together these objectives.

Finally, publicizing this methodology in other universities and establishing work networks is a necessity at present (Altarejos, Rodríguez, and Fontrodona, 2003). Universities must promote Development Cooperation Programs to achieve enriching exchanges and teacher training.

References

Altarejos, F., Rodríguez, A. y Fontrodona, J. (2003). *Retos educativos de la globalización*. Pamplona: Eunsa.

Aznar-Minguet, P., Ull, M. A., Martínez-Agut, M. P. y Piñero, A., (2017). Evaluar para transformar: evaluación de la docencia universitaria bajo el prisma de la sostenibilidad. *Enseñanza de las Ciencias*, 35(1), 5-27. Disponible en: http://www.raco.cat/index.php/Ensenanza/article/view/319566.

Aznar-Minguet, P., Ull, M. A., Piñero, A. y Martínez-Agut, M. P. (2017). La evaluación de la formación de formadores. Un catalizador en el proceso de cambio curricular hacia la sostenibilidad. *Revista Iberoamericana de Educación*, 73, 225-252, Disponible *en: rieoei.org/rie73a10.pdf.*

Cortina, A., Escámez, J., García López, R., LLopis, A. y Ciurana, C. (1998). *Educar en la justicia*. Valencia: Generalitat.

Escámez, J. (2004). La educación para la promoción de los derechos humanos de la tercera generación. *Enconters on education*, 5, 81-100.

Escámez, J. (2008). *Ciudadanía, sociedad civil y participación. Una mirada pedagógica*. A Coruña: Netbiblo.

Martínez, M. (Coord.) (2008). *Aprendizaje servicio y responsabilidad social de las universidades*. Barcelona: Octaedro.

Martínez-Agut, M. P., Aznar, P., Ull, M. A. y Piñero, A. (2007). Promoción de la sostenibilidad en los currícula de la enseñanza superior desde el punto de vista del profesorado: un modelo de formación por competencias. *Educatio Siglo XXI, 25*, 187-208.

Martínez-Agut, M. P. (2015). Objetivos de Desarrollo Sostenible (ODS, 2015-2030) y Agenda de Desarrollo Post 2015 a partir de los Objetivos de Desarrollo del Milenio (2000-2015). *Quaderns d'animació i educació social*, *21*, 1-16. Disponible en: http://quadernsanimacio.net/index_htm_files/desarrollo.sostenible.pdf

Martínez-Agut, M. P. (2016): 2015: Año de Transición en Educación y Sostenibilidad. *Quaderns d'animació i educació social*, *23*, 1-23. Disponible en: http://quadernsanimacio.net/index_htm_files/2015.pdf

Martínez-Agut, M. P. (2017): De 2016 a 2017, por la Educación y la Sostenibilidad. *Quaderns d'animació i educació social*, *25*, 1-14. Disponible en: http://quadernsanimacio.net/index_htm_files/2016.pdf.

Martínez-Agut, M. P. (2018). Año 2017 y Sostenibilidad. Recopilación Internacional, Nacional y Local con Informes de diversos Organismos y Entidades. *Quaderns d'animació i educació social*, *28*, 1-29. Disponible en: http://quadernsanimacio.net/index_htm_files/Ano%202017.pdf

Puig, J. M., Batllé, R., Bosch, C. y Palos, J. (2007). *Aprendizaje servicio. Educar para la ciudadanía*. Barcelona. Octaedro.

Puig, J. M. (Coord.) (2009). *Aprendizaje servicio (Aps). Educación y compromiso cívico*. Barcelona. Grao.

Ull, M. A., Aznar, P., Martínez, M. P., Palacios, B. y Piñero, A. (2008). Competencias para la sostenibilidad y currícula universitarios. *Enseñanza de las Ciencias*, Número Extra VIII Congreso Internacional sobre Investigación en Didáctica de las Ciencias, 2964-2967.

UNESCO (2014). *Documento de Programación de País de la UNESCO para la República de Cuba 2014. 2018*. La Habana. UNESCO.

UNESCO (2017a). *Educación para los Objetivos de Desarrollo Sostenible. Objetivos de aprendizaje*. París: UNESCO.

UNESCO (2017b). *Orientaciones sobre la ciencia de la sostenibilidad en la investigación y la educación*. 2017/SC/SHS/1. Disponible en: https://en.unesco.org/sites/default/files/sus_guidelines_spanish_f_0.pdf

UNESCO (2017c). *La educación transforma vidas*. París: UNESCO. Disponible en: http://unesdoc.unesco.org/images/0024/002472/247234s.pdf

UNICEF (2015). *El aprendizaje bajo la lupa: Nuevas perspectivas para América Latina y el Caribe*. Panamá: Oficina Regional para América Latina y el Caribe.

UV (2017). *RESOLUCIÓN de 16 de octubre de 2017del Vicerrector de Internacionalización y Cooperación de la Universitat de València, por la que se convocan y se establecen las bases reguladoras de la convocatoria de Becas JóvenesInvestigadores 2018del Programa de Cooperación 0'7 de la Universitat de València, destinadas a investigadores de países vías de desarrollo*. Disponible en: https://www.uv.es/coopweb/1_Programas_propios_becas/1_2_Investigacion_UV/1_2_1_Jov_Inv/2017%20Convo%20Jov%20Inves%202018%20Cast.pdf

UV (2018). Resolución de 29 de octubre de 2018 del Vicerrector de Internacionalización y Cooperación de la Universitat de València por la que se convocan Ayudas de Movilidad por Convenio Marco entre la Universitat de València y otras instituciones de Educación Superior extranjeras de países de cooperación al desarrollo para el año 2019. Disponible en: https://www.uv.es/coopweb/1_Programas_propios_becas/1_3_PDI_PAS/1_3_1_Movilidad_Convenio_Coop/2019%20Conv%20Ay%20Mov%20Coop%20castellano.pdf

UV (2019). *Cooperación*. Disponible en: https://www.uv.es/uvweb/universidad/es/relaciones-internacionales/cooperacion/novedades-1285936523030.html

C-2

The Learning-Service as an educational model: introduction strategies in the subjects of Degree, Master and Doctorate in the University of Valencia

M. Pilar Martínez-Agut[1]*, Anna Monzó Martínez[1],
Pedro José Herreros Martínez[2], José Daniel López Jiménez[2],
Concha Barceló López[3], Maikel Pons Giralt[4] y Ana María Ramón Sánchez[2]

[1] Universitat de València (Proyecto REDUVAPS-Red de Aprendizaje-Servicio de la Universitat de València, UV-SFPIE_GER18-844761)
[2] Universitat de València
[3] Centre de Formació, Innovació i Recursos per al professorat d'Educación Inclusiva (CEFIRE)
[4] Universitat de Camagüey (Cuba)
*mdelpi@uv.es

Keywords: Sustainable Development Goals (SDGs), key transversal competences, Service-Learning, training stays, institutionalization of the ApS

Introduction

The coming decades of this century will probably be decisive in terms of changes and social and environmental improvements. This fact is known by the political leaders of the different nations that make up the UN, and this was reflected in the 2030 Agenda by setting the Sustainable Development Goals (SDG), seventeen proposals that link global needs with social participation and education. . Although achieving these objectives for the date marked would be more than desirable, it is not an easy task. From the educational field we must contribute with strength, professionalism and creativity to make them more accessible (UNESCO, 2017).

Through methodologies such as Service Learning (APS), we can collaborate in the journey of this path already started, since it links the educational and the social with the idea of providing changes and improvements to the community.

One of the fundamental objectives of the University is to train competent professionals in different fields, prepared to be part of society and its professional environment in an active and relevant way. Learning-Service is a methodology that combines learning with service to the community, in a single well-articulated project, which allows generating meaningful and applied learning with a commitment to the environment and participation in an active citizenship, since the Students act as committed citizens, a form of direct learning of participation in society (Batlle, 2011; Martínez, 2008).

On the other hand, the Learning-Service methodology promotes competences such as problem solving, motivation to learn, interpersonal communication, ability to observe and apply knowledge, personal development, commitment to democratic values and solidarity, to improve critical thinking and skills of communication and planning, in an active participation in organized activities serving the real needs of the community, based on the subject programs, through commitment to the community (UNICEF, 2015).

This methodology presents as characteristics, that new knowledge is learned and a personal development takes place; it requires the active participation of students; and a systematic organization; the goal is the needs of the community; coordination is required between the formal or non-formal educational institution and the community receiving the service; generates civic responsibility; the service is integrated into the academic curriculum or into the formative proposals of the non-formal educational entities; It is necessary to dedicate a time previously planned for reflection on the experience (Puig, Batllé, Bosch, and Palos, 2007).

Results and Discussion

Entities that enhance the ApS

CApSa and UVApS program

The cApSa program, promoted by the Universitat de València to make visible, empower and recognize this methodology that is characterized by being proactive, cooperative, participative and transformative, both in teaching (training university professors, making their action visible, supporting them with didactic material and creating the RAGALO award for the best APS presented by the students in all areas) and in the research (with the UVAPS network —Universidades Valencianas for the ApS—), promoting a network of researchers from innovation, transfer and research (Universitat de València, 2019a).

The network of Valencian Universities for the ApS (UVApS) arises in the Universitat de València from a project of institutionalization of the ApS, which aims to stimulate, visualize and prioritize the research arising from the different subjects and existing projects around this methodology, It is a network formed by members of different higher education institutions of the Valencian Community that intend to disseminate this learning methodology, promote practices and establish links between all of them Universitat de València, 2019b).

Grup promotor de l'ApS de la Comunitat Valenciana

It wants to offer a meeting framework for the people interested in the ApS, together with the contact with the groups and centers of promotion of the ApS in Spain. The coordination team integrates teachers from educational and university centers, professionals and volunteers from social entities, municipal technicians, promoting courses and conferences (Grup promotor de l'ApS de la Comunitat Valenciana, 2019).

Introduction of the ApS in the levels of Degree, Master and Doctorate

The introduction of the Learning-Service methodology in the subjects of Degree, Master and Doctorate in the Universitat de València has been implemented since several academic courses in different subjects, in which this work is taken into account as part of the evaluation of the subject (with a percentage that tends to be over 25% of the overall mark), and the realization of the group, with an accompaniment by the teacher (Martínez-Agut, 2014).

Specifically, in the Faculty of Philosophy and Education Sciences has been implemented in subjects of Degree, Master and Doctorate.

In Degree:In the Degree in Social Education, the third year the APS is introduced jointly in five subjects, and in this way a common project is unified to all the teachers of the different subjects and their contents, creating a collaboration and understanding focusing the effort towards the same direction; students understand the academic year as a whole and not as unconnected subjects, giving more meaning to their training in Social Education, to be able to materialize the contents in a service to the community, and that ultimately is the recipient of the work that is done within the university and promotes a feedback to the students that will facilitate their improvement as a professional.

Also in the optional subject of 4th course, "Education for Sustainability", the APS is introduced in the field of Sustainability (Martínez-Agut, 2015; 2016; 2017; 2018; Martínez-Agut, and Ull, 2014).

The Degrees of Social Education and Pedagogy, share the subject Social Pedagogy and Philosophy of Education, in which the students make an ApS linked to the subjects of the subjects (Martínez-Agut, Zamora Castillo, and Pons Hervás, 2017). Also in the Degree in Philosophy the ApS is proposed (in subjects such as Problems and Currents in Education)
Several Final Degree Projects (TFG) with this methodology have also been presented, from the Practicum, in many cases.

In Master: As an example, in the Master's Degree in Secondary Teacher Training (Universitat de València, 2019c), which presents 20 specialties and about 1000 students each year, in the subject "Process and Contexts" this methodology is presented; there is an option in the Final Master's Project (TFM) to be able to apply it and some works have been elaborated, and also in the Practicum it is observed how in some centers it is carried out.

In Doctorate: In the Doctoral Program in Education, this line of research is presented to doctoral students in training seminars, and is offered as a research option.

Some doctoral theses have been defended in this field. There are 4 doctoral theses, of which two have been defended at the Universitat de Valéncia (Escoda, 2018; Zayas, 2015).

Conclusion

The students and the university teaching staff have to be linked with their context and with their community in education for sustainability, and in the Learning-Service methodology it presents the possibility of relating the learning of the university curriculum with the service to the community. Making this methodology known in other universities and establishing work networks is a necessity at present (Altarejos, Rodríguez and Fontrodona, 2003). The universities have been to promote the Learning-Service to give back to society.

Conducting an analysis, from the degrees of the Faculty of Philosophy (Degrees in Philosophy, Pedagogy and Social Education) this methodology is used and is part of the programming of different subjects and grades as usual, including Final Degree Works and in the Practicum .

In the Master's Degree in Secondary Education there is a more important plant, this methodology is presented but it is more complicated, as well as a great academic load in a course. It could be strengthened more from the completion of Final Master Projects, and the students will enhance this practice in the practical, to teachers in active.

In the field of doctor have defended two theses in the University of Valencia of this subject, very relevant, but it is necessary to continue promoting the investigation and the diffusion in the articles and Scientific Meetings.

References

Altarejos, F., Rodríguez, A. y Fontrodona, J. (2003). *Retos educativos de la globalización*. Pamplona: Eunsa.

Aznar-Minguet, P., Ull, M. A., Martínez-Agut, M. P. y Piñero, A., (2017). Evaluar para transformar: evaluación de la docencia universitaria bajo el prisma de la sostenibilidad. *Enseñanza de las Ciencias*, 35(1), 5-27. Disponible en: http://www.raco.cat/index.php/Ensenanza/article/view/319566.

Aznar-Minguet, P., Ull, M. A., Piñero, A. y Martínez-Agut, M. P. (2017). La evaluación de la formación de formadores. Un catalizador en el proceso de cambio curricular hacia la sostenibilidad. *Revista Iberoamericana de Educación*, 73, 225-252, Disponible *en: rieoei.org/rie73a10.pdf.*

Batlle, R. (2011) ¿De qué hablamos cuando hablamos de aprendizaje-servicio? *Crítica*, *972*, 49-54.

Cortina, A., Escámez, J., García López, R., LLopis, A. y Ciurana, C. (1998). *Educar en la justicia*. Valencia: Generalitat.

Escámez, J. (2004). La educación para la promoción de los derechos humanos de la tercera generación. *Enconters on education*, 5, 81-100.

Escámez, J. (2008). *Ciudadanía, sociedad civil y participación. Una mirada pedagógica*. A Coruña: Netbiblo.

Escoda. E. (2018). *Eficacia del Aprendizaje Servicio en Dimensiones Académicas, Personales y Sociales Clave, y su incidencia en la satisfacción estudiantil en la docencia universitaria: una experiencia desde la Titulación de Trabajo Social*. Tesis doctoral inédita. Valencia: Universitat de València

Grup promotor de l'ApS de la Comunitat Valenciana (2019). Apscomunitatvalenciana. Disponible en: https://apscomunitatvalenciana.net/about/

Martínez, M. (Coord.) (2008). *Aprendizaje servicio y responsabilidad social de las universidades*. Barcelona: Octaedro.

Martínez-Agut, M. P., Aznar, P., Ull, M. A. y Piñero, A. (2007). Promoción de la sostenibilidad en los currícula de la enseñanza superior desde el punto de vista del profesorado: un modelo de formación por competencias. *Educatio Siglo XXI, 25*, 187-208.

Martínez-Agut, M. P. (2014). El Aprendizaje Servicio en la formación inicial de los educadores sociales. *Revista de Educación Social (RES) 18*, 1-18. (enero). Disponible en: http://www.eduso.net/res/pdf/18/e1e19_res_18.pdf

Martínez-Agut, M. P. (2015). Objetivos de Desarrollo Sostenible (ODS, 2015-2030) y Agenda de Desarrollo Post 2015 a partir de los Objetivos de Desarrollo del Milenio (2000-2015). *Quaderns d'animació i educació social*, *21*, 1-16. Disponible en: http://quadernsanimacio.net/index_htm_files/desarrollo.sostenible.pdf

Martínez-Agut, M. P. (2016): 2015: Año de Transición en Educación y Sostenibilidad. *Quaderns d'animació i educació social*, *23*, 1-23. Disponible en: http://quadernsanimacio.net/index_htm_files/2015.pdf

Martínez-Agut, M. P. (2017): De 2016 a 2017, por la Educación y la Sostenibilidad. *Quaderns d'animació i educació social*, *25*, 1-14. Disponible en: http://quadernsanimacio.net/index_htm_files/2016.pdf.

Martínez-Agut, M. P. (2018). Año 2017 y Sostenibilidad. Recopilación Internacional, Nacional y Local con Informes de diversos Organismos y Entidades. *Quaderns d'animació i educació social*, *28*, 1-29. Disponible en: http://quadernsanimacio.net/index_htm_files/Ano%202017.pdf

Martínez-Agut, M. P. y Ull, M. A. (2014). La educación para la sostenibilidad en la formación inicial de los profesionales de la educación social. *Revista de Educación Social (RES) 18*, 1-14. (enero)

http://www.eduso.net/res/pdf/18/e1e15_res_18.pdf

Martínez-Agut, M. P., Zamora Castillo, A. C. y Pons Hervás, E. (2017): Aprendizaje-Servicio: Dependencia y personas mayores en formación profesional y en la Universidad, En F. J. Carrillo-Rosúa, J. L. Arco-Tirado y F. D. Fernández-Martín. *Investigando la Mejora de la Enseñanza Universitaria a Través del Aprendizaje Servicio. Researching The University Teaching Through Service-Learning* (pp. 207-214). Granada: Universidad de Granada. Disponible en: https://www.uv.es/aps/doc/Biblioteca%20Blog/NP%20Investigando%20la%20mejora.pdf

Puig, J. M., Batllé, R., Bosch, C. y Palos, J. (2007). *Aprendizaje servicio. Educar para la ciudadanía*. Barcelona. Octaedro.

Puig, J. M. (Coord.) (2009). *Aprendizaje servicio (Aps). Educación y compromiso cívico*. Barcelona. Grao.

Ull, M. A., Aznar, P., Martínez, M. P., Palacios, B. y Piñero, A. (2008). Competencias para la sostenibilidad y currícula universitarios. *Enseñanza de las Ciencias*, Número Extra VIII Congreso Internacional sobre Investigación en Didáctica de las Ciencias, 2964-2967.

UNESCO (2017a). *Educación para los Objetivos de Desarrollo Sostenible. Objetivos de aprendizaje*. París: UNESCO.

UNESCO (2017b). *Orientaciones sobre la ciencia de la sostenibilidad en la investigación y la educación*. 2017/SC/SHS/1. Disponible en: https://en.unesco.org/sites/default/files/sus_guidelines_spanish_f_0.pdf

UNESCO (2017c). *La educación transforma vidas*. París: UNESCO. Disponible en: http://unesdoc.unesco.org/images/0024/002472/247234s.pdf

UNICEF (2015). *El aprendizaje bajo la lupa: Nuevas perspectivas para América Latina y el Caribe*. Panamá: Oficina Regional para América Latina y el Caribe.

Universitat de València (2019a). *¿Sabes qué es cApSa?*. Disponible en: https://www.uv.es/uvweb/centro-formacion-calidad-manuel-sanchis-guarner/es/capsa/aps-uv/capsa-1286022919165.html

Universitat de València (2019b). *UVAPS*. Disponible en: https://www.uv.es/uvweb/centro-formacion-calidad-manuel-sanchis-guarner/es/capsa/uvaps-1286023153837.html

Universitat de València (2019c). *Máster Universitario en Profesor/a de Enseñanza Secundaria*. Disponible en: https://www.uv.es/uvweb/master-profesorado-secundaria/es/master-universitario-profesor/educacion-secundaria-1285886102735.html

Zayas, B. (2015). *La Formación Cívica del alumnado universitario: Análisis de sus Percepciones acerca del Aprendizaje-Servicio (ApS) como herramienta de participación ciudadana*. Tesis doctoral inédita. Valencia: Universitat de València.

C-3

Environmental sustainability of the Miravalles Geothermal field and its socio-environmental impact in the sector of the Miravalles Volcano, Bagaces, Costa Rica

Bryan Eduardo Moncada Villegas

Instituto Tecnológico de Costa Rica (TEC)
bryanmoncada25@gmail.com

Introduction

This work aims to show the sustainable engineering developed by the Costa Rican Institute of Electricity and how its policy of respect for the environment has managed to restore the flora and fauna in the sector of the Miravalles volcano turning today a large part of the area into a national park.

On April 8, 1949, through Decree-Law No. 449, the Costa Rican Electricity Institute (ICE) was created, which would ensure the efficient and responsible use of Costa Rica's water resources. This institution would then have the purpose of taking the electrical development to all regions of Costa Rica. Thus each Costa Rican could enjoy the advantages of technological progress regardless of their economic condition. The ICE, was created as an autonomous institution responsible for the development of the sources of electricity production in the country. Since its creation, the primary objective of ICE is to develop the Costa Rican energy potential and supply electric power with quality, coverage and opportunity. With this vision, ICE has achieved for more than 66 years to meet the demands of electricity, not only of Costa Ricans, but also of some countries in the area. Today, Costa Rica is fed by a unique and interconnected system, whose administration is exclusive of ICE. This has reached acoverage of 99.4% of the nation; it is the second with the highest penetration and the cleanest in Latin America. Under this structure, it bases its generation on five main renewable sources, in order of volume: water, heat from the earth, wind, sun and biomass. As a complementary and supportive means, it uses hydrocarbons [1].

The Miravalles region, located between the districts of Fortuna and Guayabo de Bagaces, in the province of Guanacaste and Aguas Claras de Upala, in the province of Alajuela, was declared a protected area as of March 16, 1976 (through executive decree No. 5836-A).

Its main reference is the highest volcano in the Guanacaste Range: the Miravalles volcano, with an altitude of 2028 meters. This volcano has an inactive crater, with lava flows that descend towards its ancient fumaroles and merge with the jungles that cover it. The areas near the base of the volcano have vestiges of volcanic activity. The last recorded eruption was a small gas explosion that occurred in 1946 [1].

Due to the high hydrothermal activity, ICE installed the Miravalles Geothermal Project in the area, where electricity is generated by the steam that emanates from the volcano. In addition, there is an important wind, hydroelectric and solar potential in the area that is used by the I.C.E. and private companies for the generation of clean energy. The climate in this region has temperatures that range between 15° C (59° F) and 32° C (90° F). and its average annual rainfall is 3,500 mm. (140 inches). Miravalles, is a region of imposing bucolic landscapes surrounded by environments and ecosystems in which there is a great variety of flora and fauna, populated by primary cloud forests, humid forests where bromeliads, heliconias, palms, orchids, cedar trees, oaks abound , jícaros; rivers of crystalline waters, waterfalls, fumaroles, springs of thermal waters and cold waters in whose vicinity you can observe the fauna: monkeys, anteaters, felines, coyotes, white-tailed deer, tapirs, birds of various species such as: bell-birds [2].

The transition of clean energy came about in the mid-70s, when the global hydrocarbon crisis prompted the search for more efficient and profitable energies. It was then that Costa Rica designated and brought Dr. Alfredo Mainieri Protti, an Italian specialist in geothermal energy, to investigate and search for feasible sites to produce geothermal energy. This is how the country's first geothermal project was born, which was located in La Fortuna de Bagaces, with direct influence on the La Fortuna and Guayabo communities. It has an installed capacity of 204 MW installed. It started its operation in 1994 and is known for being the first in the world to reinject all the fluids extracted from the steam reservoirs, which allows a greater conservation of the resource [2].

Results and analysis

Figure 1. Changes in flora and fauna of the areas near the Miravalles volcano (3)

Figure 1 shows the changes in the area near the volcano over the years where it is possible to observe the evident recovery of forest and therefore of flora and fauna.

All this recovery is thanks to the environmental policies of Costa Rica and ICE, all this starts from the inclusion of the environmental variable within Article 50 of the Political Constitution, in 1994, it is established that every Costa Rican citizen have the right to a healthy and ecologically balanced environment. From this article, a whole legal framework of reference emerges in Costa Rica, based on this modification of the Magna Carta. In 1995 under the constitutional protection of Article 50, Costa Rica publishes the Organic Law of the Environment (LOA), Law No. 75544, which dictates its first article "will seek to provide Costa Ricans and the State with the necessary instruments to achieve a healthy and ecological environment" [3].

The environmental policy of the ICE commits the institution to "efficiently and effectively manage its processes to meet the electric power requirements and specialized services of the client, anticipating pollution, preserving the environment, promoting a safe, healthy work environment and controlling the risks of the business, under criteria of continuous improvement and compliance with current legislation and other applicable requirements. "This policy governs the general guidelines and procedures for the environmental and social management of ICE. Within these policies we can find the following [4].

Table 1. Environmental policies of the ICE

Policy, guidelines or protocol established	Objective
Environmental policy of the Electricity Sector	Create a reference for good environmental management and practices that includes compliance with environmental regulations, ensuring the reasonable use of resources, protection and environmental recovery, environmental awareness and education, and finally, their contribution to sustainable development.
Environmental Guidelines of the Electricity Business	Focus on the rational use of natural resources and ensure that any work to be done is to maximize the benefit to surrounding communities and minimize negative impacts.
Social Responsibility Policy	Support the development of communities in areas of influence of projects to the point of supporting the creation of new small businesses.
Green purchasing guidelines	Ensure that in the acquisition of goods and services, environmental requirements related to one or several stages of the "life cycle" of the product to be purchased are contemplated.
Wildlife Monitoring and Research Protocol	Look for consistency in the execution of monitoring and wild research in order to understand the response of the fauna to changes in land use and the introduction of species rescued in some places.
Protocol for the Evaluation of Water Quality	This protocol establishes the methodology for the evaluation of the quality of surface water bodies so that the information supports the implementation of management plans and decision making.
Protocolo Infraestructura Protección de Fauna	Create an adequate procedure for the protection of wildlife in the works of the ICE. It establishes a series of actions to prevent the death of animals.
Protocol Infrastructure Protection of Fauna	Understand the quality of surface water in the area of influence of the facilities and is used to support mitigation and management plans.
Protocol for the Management of Animals in ICE Facilities	Minimize the entry of wild or domestic animals in the ICE sites, in order to prevent the abuse of them, and minimize the possibility of transmission of diseases or pests as a result of their proximity.
Protocol of Clinical Aspects	Focus on the consistency of clinical management of wildlife species rescued, in order to reduce the mortality of species and be able to release individuals to the environment.
Protocol Methodology for Diversion of Channels	Establish the procedure to follow in the change of course of courses during the execution of works, seeking the generation of technical information required to compensate and mitigate the impacts of these actions.
Protocol of Rescue and Translocation of Flora and Fauna	Prevent the destruction of the species present in the area of influence of the projects.
Protocol of Ecological Restoration	Carry out actions to restore ecosystems affected by ICE activities, in addition to serving as alternatives for mitigation processes.

The Costa Rican Electricity Institute plans and executes its activities based on the principle of sustainable development; Its management is carried out with an attitude of conservation, protection, recovery and responsible use of the environment [5]

Thanks to all the protocols, guidelines and policies mentioned in Table 1, ICE has not only been able to regenerate a large part of flora and fauna in the Miravalles region, but has also been able to develop a completely sustainable and compatible with the environment engineering. for example, it does not generate contamination of surface aquifers. Geothermal systems are designed in such a way that the extracted fluids return to the reservoir, this allows to avoid contamination of the environment and additionally ensures a longer life of the field. The environmental impacts by noise are only generated during maintenance activities of the systems, under normal operating conditions the noise generated in the wells and field structures are minimal and easily overcome by the ambient noise (wind, etc)

Due to the configuration of the facilities and their design, the visual impact of these projects is very low and easily controllable, in fact in many countries and Costa Rica does not have to be the exception, this type of projects are attractive from the point of view tourist, so it can mean a great benefit for the communities dedicated to tourism.

The effects on the environment are punctual and reversible. The surface facilities occupy small areas and if they are not required, they can be easily removed and the areas where they are located can be recovered. Contributes to the enrichment of biodiversity due to the recovery of areas (reforestation).

Conclusions

The institutional policies managed by ICE to maintain sustainable development have proven to be extremely effective since they have made it possible to make an evident series of changes in the Miravalles region, both environmentally and socially.

This project shows a clear example of which large-scale engineering projects are compatible with the conservation and recovery of the environment, since to date all the ICE properties in Miravalles have been recovered and are already important development forests. So much so that in the month of July will be inaugurated the Jorge Manuel Dengo Oregon national park, which covers the entire area of the Miravalles volcano, where undoubtedly the ICE is one of the great influencers in the restoration of flora and fauna of much of the sector of the National Park.

A sustainable engineering development with the environment also benefits the surrounding towns. The Miravalles Geothermal field is a living example of how the exploitation activity of a geothermal field contributes to the social and economic development of neighboring communities. For the communities of Guayabo, Fortuna, San Bernardo, Aguas Claras mainly because it promotes tourism in the area and also provide sources of work for the inhabitants of the area which promotes the development of localities. It is also an economic benefit for the Country. Geothermal exploitation, being basic energy, is used as a substitute for thermal production and therefore means a great saving of money for the country. The current global crisis due to the price of hydrocarbons obliges countries to seek generation alternatives using domestic resources, and in this case Costa Rica has great geothermal potential that should be exploited.

References

1. Instituto Costarricense de Electricidad. (s.f.). Grupo ICE. Recuperado el Mayo de 2019, de www.grupoice.com
2. Fernández, E. (26 de Julio de 2018). Cuatro energías limpias emanan del volcán Miravalles. Periódico Mensaje, pág. 1.
3. Calvo, R. N. (Agosto de 2015). Estudio de Impacto Ambiental y Social Complementario Proyecto Geotérmico Las Pailas II. Costa Rica: Instituto Costarricense de Electricidad.
4. Calvo, R. N. (Agosto de 2015). Evaluación Ambiental Estratégica (EAE) Línea de Crédito Condicional para Proyectos de Inversión para el Programa de Energía Renovable, Transmisión y Distribución de Electricidad en Costa Rica. Costa Rica: Instituto Costarricense de Electricidad.
5. Instituto Costarricense de Electricidad. (s.f.). Certificados ISO 9001, 14001 y OHSAS 18001. Costa Rica: Instituto Costarricense de Electricidad.

C-4

Sustainability and institutionalization model: The case of the MPIA

Claudia Islas Torres[1]*, María del Rocío Carranza Alcántar[1],
M Nuría Salán Ballesteros[2]**, Sergio Franco Casillas[1]

[1] Centro Universitario de los Altos (CUALTOS), Universidad de Guadalajara (Mexico)
[2] ESEIAAT, Universitat Politècnica de Catalunya (Spain)
*cislas@cualtos.udg.mx **nuria.salan@upc.edu

ABSTRACT

The present text deals in a general way the way in which from the Master in Innovative Processes in Learning (MPIA) that operates as a double degree by the Centro Universitario de Los Altos (CUALTOS) of the University of Guadalajara, in collaboration with the Institute of Sciences of Education of the Universitat Politècnica de Catalunya (UPC-BarcelonaTECH), has tried to promote sustainability as a transversal skill that allows the institutionalization of this topic in the University System.

The MPIA trains active teachers who develop their educational practice in different engineering or technological baccalaureates, among other educational centers; and the concern has arisen to propose a model to follow to institutionalize sustainability as a form of change and improvement of the educational context. In this sense, as a first point it is proposed that groups of volunteers can be generated to prepare themselves theoretically and practically with respect to how to pedagogically lead a sustainability project that in turn can be institutionalized [1].

From this group of volunteers will be generated the leaders that would make possible the execution of the model, once institutionalized. To comply with the above, it is necessary to use Information and Communication Technologies (ICT), since in addition to improving the productivity and efficiency of processes in organizations, they can also contribute to sustainable development by executing public plans and programs, driven by thinking minds that seek to establish clear guidelines that can be executed in the short, medium and long term [2].

To achieve success in the leadership of the institutionalization of the model, it will depend on the educational practices developed as part of the teacher training process, considering the 17 sustainable development objectives proposed by UNESCO [3].

Keywords: Sustainability, Innovative Processes, Learning methodologies, Skills

Proposal of the Sustainability Model

In accordance with what was stated in the previous paragraphs, it is proposed that from the implementation of the skills established transversally in the learning units taught in the MPIA, it is possible to educate the students that will become pedagogical leaders within each one of its institutions, this through the operation of intervention and research projects that show results that support the importance of recognizing sustainability from a formative and legal framework, establishing its functioning in a formal way through institutionalization.

Similarly, the MPIA promotes the behavior of a pedagogical leader from the perspective of sustainability, this with the aim of preparing it in a formative and ethical sense so that it becomes a person who can guide the educational community in order to improve their quality of life [4].

The following describes the skills that are distributed transversally in the learning units and that contribute to achieving the sustainability objectives:

Generic Skills

- To identify the elements that characterize the organization of a teaching center, relate the planning of teaching-learning with the results obtained and make proposals for improvement.
- To assess the complexity of social phenomena typical of the welfare society and be sensitive to social reality (plural, diverse and multicultural), to facilitate the inclusion of all students and convey an ethical commitment and the right to difference.

Specific Skills of the Basic Training Module

- To know the characteristics of the students, their social contexts and motivations
- To promote actions of emotional education, values, and civic education
- To participate in the definition of the educational project and in the general activities of the center according to criteria of quality improvement, attention to diversity, prevention of learning problems and coexistence
- To relate education with the environment and understand the educational role of the family and the community, both in the acquisition of skills and learning and in education in respect of rights and freedoms, in equal rights and opportunities between men and women and in the equal treatment and non-discrimination of persons with disabilities.
- To know the historical evolution of the family, its different types and the incidence of family context in education.
- To acquire social skills in relationship and family orientation.

Specific Skills of the Specializing Module

- Specific Skills of the Specializing Module
- To know the formative and cultural value of the subjects corresponding to the specialization and the contents that are studied in the different educational levels.
- Transform curricula into activity and work programs.
- Know and apply innovative teaching proposals in the field of education in which he ventures.
- Know and apply methodologies and basic techniques of educational research and evaluation and be able to design and develop research, innovation and evaluation projects
- Project management

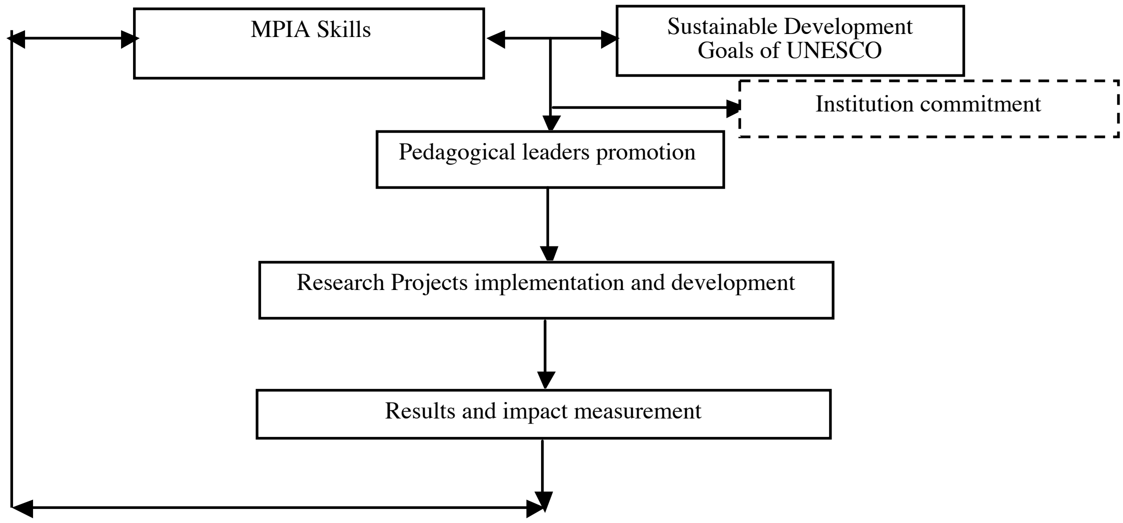
To achieve this, a sustainability model is proposed that allows institutionalization for the University System, firstly applying it directly to those who complete the master's degree with a series of skills that allow them to become the ones who promote the applicability of this model, also relying on The following sustainability objectives established by UNESCO:

Figure 1. Sustainable Development Goals of UNESCO

Source. UNESCO (https://es.unesco.org/sdgs.)

In this way, by adapting the skills of the Master's Degree with the objectives described above, the sustainability model proposed below is constructed:

Figure 2. Sustainability Model self developed



Conclusions

With the implementation of a sustainability model and its institutionalization in the field of education, one of the substantial tasks that a university must carry out, especially in the social dimension, is fulfilled, since through its teaching and research function the development is propitiated sustainable, incorporating in an integral way aspects that promote awareness and change actions for an active participation of the academic community.

In such a way that the formation of pedagogical leaders in charge of producing and operating new ways of managing educational institutions is considered fundamental, by including changes in their personal skills, focused on ethics and social commitment.

Considering that implementing models such as the one proposed can eliminate risks that endanger the environment and exhaustion of existing resources, it is taken into account that MPIA engineers are trained to teach and thus have double interference in society, on the one hand from their profession and on the other as pedagogical leaders.

References

1. Castillo, P., *et al.*, *El liderazgo compartido como factor de sostenibilidad del proyecto de comunidades de aprendizaje,* XLIII (1) , 41-59, 2017.
2. Naser, A., Gastón, C., *Rol de las TIC en la gestión pública y en la planificación para el desarrollo sostenible en América Latina y el Caribe*. (79), 1-45, 2014
3. UNESCO., *La UNESCO y los objetivos de desarrollo sostenible, 2019*
4. Sierra, G., *Liderazgo educativo en el siglo XXI, desde la perspectiva del emprendimiento sostenible,* (81), 111-128, 2016

C-5

Teaching and Learning Circular Economy to Designers. Lessons Learned from Preliminary Experiences

Elena Mulet[1]*, Kirsten Schmidt[2], Rainer Pamminger[3], Marta Royo[1], Maria Kalleitner-Huber[4], Joao Sampaio[5], Cristina Rocha[6], Ana Afonso[5]**

[1] Department of Mechanical Engineering and Construction. Universitat Jaume I. Spain
[2] Department of Planning, Aalborg University
[3] Vienna University of Technology
[4] Austrian Institute of Ecology, Vienna, Austria
[5] Communication and Art Department, University of Aveiro
[6] LNEG, I.P. - National Laboratory of Energy and Geology
*Corresponding author: emulet@uji.es **Presenting author: royo@uji.es*

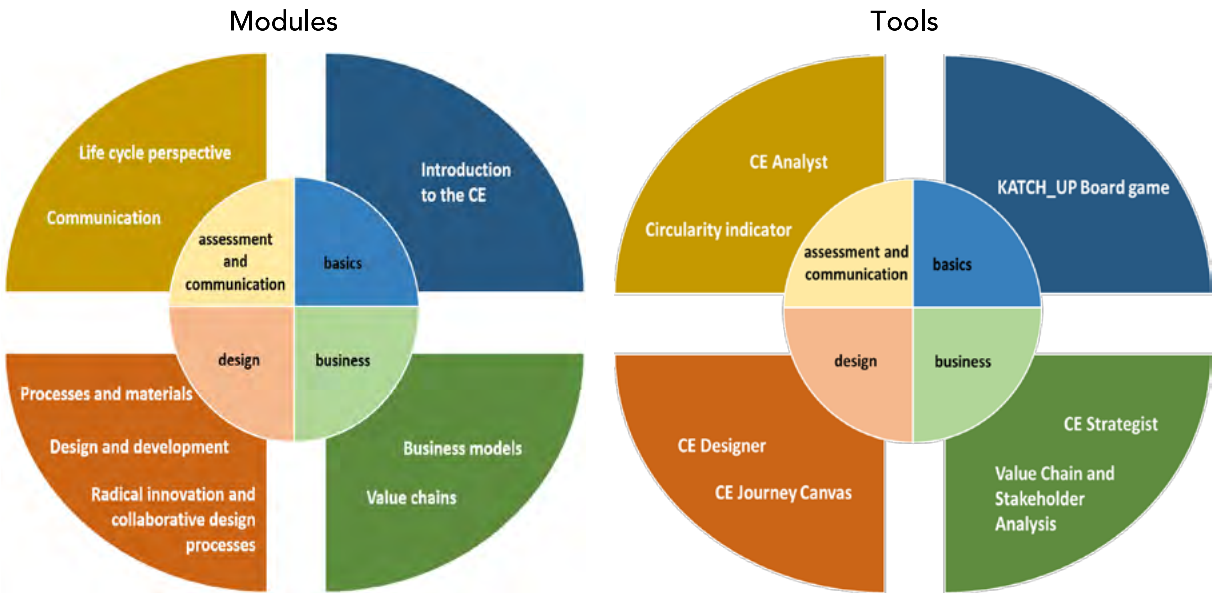
Introduction

The last 40 years' linear take-make-consume-dispose economic model creates fundamental challenges [1]. In a circular model, waste and pollution are designed out, products and materials are kept in use and values sustained for as long as possible – lowering the stress on natural systems [2]. Designers will be asked to contribute to the transition towards Circular Economy (CE) on e.g. company and societal levels. To do so, they will need multidisciplinary competences combining technical, business, environmental and social knowledge. The European KATCH_e project (Knowledge Alliance on Product-Service Development towards Circular Economy and Sustainability in Higher Education) in http://www.katche.eu/es/, develops training materials on CE, including both theoretical background materials and tools for practical implementation of CE solutions in organizations. KATCH_e aims at addressing the challenge of reinforcing skills and competences in the field of product-service development for the Circular Economy and sustainability, with a particular focus on the construction and furniture sectors.

A previous analysis of the implementation of the CE showed that the interviewed students, mostly industrial design engineering students, indicated that CE was not taught in a specific way but was included horizontally within other disciplines related to environmental science and sustainability. Some indicated that they had not received any related training and all agreed that the received training was insufficient. The interviewed teachers shared this experience. CE was not present as a course in the curricula, but some related topics were included in other subjects such as eco-design, life cycle assessment or industrial ecology [3]. This perception was similar to the results found by Whalen *et al.* [4] and Whicher *et al.* [5]. In general, teachers justified this with the low level of knowledge they had, being necessary to delve into it more deeply and introduce it in the curricula in a more systematic way. Therefore, the framework of systematic CE training was perceived as necessary.

According to the analysis of needs and the interview results, a set of specific contents on CE has been proposed in KATCH_e (Figure 1). These materials (modules and tools) meant to be used in academic teachings, in-classroom context, as well as in companies. There are eight KATCH_e modules and seven tools. They address how to define new business models, how to develop products and processes and the assessment and communication of the circularity.

Figure 1. Modules and tools developed in KATCH_e project [6]



Methodology

To secure that the elaborated materials are as useful and user-friendly as possible, they have been tested with students and professors of the four countries that are part of the Project: Portugal, Denmark, Austria and Spain. The testing phase comprises a large number of activities. This abstract shows some of the reflections for a better learning that have been reached after teaching part of the content. Next table summarizes the four teaching experiences, one per country, from which this preliminary study is done (Table 1).

Table 1. Summary of the teaching CE experiences to designers

What	Teaching approach	Hours	Attendants	Who and country
Module: Introduction to CE as part of Sustainable Design	PBL [7]. The use of the materials takes place during the student's semester project	3 hours + 2 hours follow-up	37 international Sustainable Design Master students	3 professors Denmark
Module: Four radical innovation techniques for CE	Independent workshop	12 hours. A 3 hours session per technique	12 Design bachelor students	4 professors Spain
Module: Indtroduction into CE Module: Life cycle perspective Tool: CE Designer Tool: CE Strategiest	Full Lecture: mix of frontal lecture and workshop like group works	15h	28 Ecodesign Master students	2 professors Austria
Product Design within Circular Economy	Optional curricular unit	42 hours	10 Master Design Students + 10 Master students with various backgrounds	7 professors Portugal

Explanation of activities in Denmark:

1. 2 hours introduction to CE + 1 hour group based brainstorming on "The 10 Essentials of CE" (Figure 2) and how they could be related to the student's semester projects. First week of the semester. The purpose was to raise the students' awareness on CE and stimulate them to incorporate CE aspects in their semester projects. The projects are defined by the students and include problem analysis and problem solutions.

Figure 2. The 10 essentials to guide the Circular Economy [8]

1. Think circularity already in the design phase of products and business models
2. Think in functionality instead of products
3. Analyse where value is created and destroyed, to understand how it can be captured
4. Any circular solution should also be sustainable
5. Assess the consequences and relevance of your solutions from a life cycle perspective to avoid moving problems, or creating new ones
6. Involve the stakeholders along the value chain in developing new solutions
7. Adopt a stewardship role and lead the transition to a circular economy by example
8. Understand which new, or changed, practices are needed to make your circular solution work
9. Make the circular solutions attractive for the users and be a part of the solution, not the problem
10. Consider if local social value can be applied as a part of reuse and refurbishment

2. 2 hours follow up session two days later where student groups presented their ideas for semester projects, including which CE aspects they intended to focus on. Feedback was given from the professors and their fellow students.
3. During the next 4 months, students worked in groups on their semester projects. Some groups had CE as a specific focus point, while others chose to primarily work with other approaches to sustainability.

For the radical innovation techniques tested in Spain a 12 hours workshop was done, divided in 4 sessions, one for each technique: rolestorming, scenario creation, circular brainstorming and biomimicry. The teaching method applied was:

1. Brief introduction about the Circular Economy
2. An explanation of the method, showing method step by step application to a predefined example.
3. Students apply the method to a new example under supervision.
4. Students apply the method to a project under supervision. This project is used with the 4 methods, during the 4 sessions.

In Austria, training materials and tool has been tested as part of the lecture: Product design within the master course Ecodesign at the applied university of Wieselburg.

1. An introduction on general environmental issues and on CE has been given (2h)
2. An interactive lecture about the life cycle perspective module (3h), asking the students different questions and giving them small assignments, as comparison of EPDs of building materials, finding the differences, etc.
3. Group work (10h): after this first insight, the students got their assignments, meaning each group of student (2-4 Students) got a specific product (coffee machine, washing machine, blender, etc.) which they had to improve in terms of their circularity and the their environmental impact.

   - First, they calculate the Product Carbon Footprint (3h+1h Presentation). This calculation resulted in the environmental profile of the product. With this result, they could indicate the environmental hotspots of the product and could already think of possible improvements. These results had to be presented.
   - Secondly, the students should think of improvements of their products in terms of its circularity (2h), using the circular design strategies within the developed tool CE Designer. As the students have calculated the environmental impact they knew where there was a high interest to use less resources, to use resources more intensively or for a longer time or to close the loop. In the end, they came up with a list of ideas for improvement.
   - Thirdly, they had to think of a business model to exploit the improved circular product (3h+1h Presentation). If, for instance, they have developed a high quality modular product, business models are needed which support this modularity e.g. selling spare parts and provide repair service or services to secure product take back after use in order to get back the valuable components and to be able to reuse them. To support the students in this task they used the developed tool CE Strategist, following the given circular business model strategies to define a business model using the Business Model Canvas. In the end, the students had to present their full results.

Regarding the testing activities in Portugal, the University of Aveiro implemented a new multidisciplinary optional curricular unit, entitled: Product Design within Circular Economy. This curricular unit featured the contribution of teachers from various backgrounds and also tested, during one semester, contents of selected modules developed within the KATCH_e project. Teaching and learning methodologies where based on a balanced combination between audiovisual exposure, debates, discussion and critical grounding of project decisions, and project monitoring based on individual and practical group work. The exercise proposed to the students was to design and develop a piece or set of furniture pieces in cork and another material. This intended to foster partnership and proximity with the company involved in KATCH_e and to promote sensitivity to the relations between product, market and technology through the practice of Design for CE.

The project was developed by multidisciplinary teams of students who incorporated their knowledge during the exercise and according to the extensive inputs given on Circular Economy throughout the 3-hour classes. Classes happened during one semester, once a week, with various teachers, following different approaches to CE, from Introduction, to Business models for the CE and Materials and Processes, including modules on Radical Innovation and Challenges to product development according to CE.

Results

This section describe the reflections made after the four teaching experiences concerning presenting Circular Economy to Design Students. Concerning the Danish experiences, the good points observed was that many of the students found CE relevant and interesting to work on, and chose to incorporate elements of CE in their projects – and 2 of 9 groups even had CE as their primary focus. The specific, yet broad, KATCH_e definition of CE and the developed 10 Essentials of CE helped the students understand the challenging complexity of the topic. The KATCH_e modules handed out to the students supported their further analysis of e.g. how to redesign a product to become more circular, and what type of business model will go in line with the design. As a negative point, students struggled to become concrete in their discussions of the 10 Essentials during the introduction lecture since they needed more knowledge. As an improvement idea, the 10 Essentials exercise could be repeated at the end of the semester thus showing the students what they have learned during the semester. Another learning point is, that the professors giving feedback to the students' project proposals on the follow up session need quite some knowledge on CE and should be able to give examples on practical CE solutions.

Concerning the Spanish experience, the good points observed during the teaching of the radical innovation techniques are that the applied sequence helps understanding the methods and finding new ideas. In addition, supplementary material (answer templates in circular brainstorming) are highly appreciated. As negative points observed, biomimicry is difficult to apply. In some cases, students have applied scenario creation in a different way than pretended. Improvement ideas for this content are to include supplementary material as optional resource as answer templates and step by step solved exercises.

As the students in Austria already had some pre-knowledge in CE they found the Introductory section a bit boring. What they generally liked was the methodological approach in using the environmental assessment as analysis instrument for the selection of the right design strategies but also as proof that the new circular design is better than the reference design. They also like very much to work with the guidelines of the CE Designer and the CE Strategist as this helped them deriving new product concepts and business models. Difficult for them was the business model canvas as this was completely new for them.

Concerning the Portuguese experience, students from various backgrounds, as Design, Engineering and Product Design, Economics, Civil Engineering, Environmental Engineering and Materials Engineering, revealed interest on the curricular unit. There was a very good response to the proposed exercises, revealing the student's capacity to start with the analysis and investigation of the CE principles and existing products in the market, forwarding to the deconstruction of the problem or opportunity to the communication of the solution. Design students revealed capacity to reflect CE principles on their products proposals and related to the other students in order to create robust furniture projects based also on services and concepts such as renting, sharing and customer relations. Negatives points emerged from students having different previous knowledge on CE and having to create common ground between all of them. Student's evaluation of the curricular unit mentioned they missed more practical and hands-on cases, and also not giving too much theoretical content at a time. Making the content more related to the subject of the project proposal was also mentioned.

Conclusions

Circular Economy is a very complex topic for students to learn and for teachers to teach. Elements of CE can be included in existing courses, or as additional initiatives, and such initiatives may raise awareness on CE but cannot guarantee deep learning. Therefore, training activities over a longer period of time should be considered for the students. Teachers will also need additional training to be able to support their students. In the KATCH_e project, we have engaged in developing a MOOC (Massive Online Open Course) that may support life long learning among teachers and professionals outside academia.

These experiences demonstrated the huge task to help students learn such a complex issue as Circular Economy. The experiences in which the general concepts, this is, the circular approaches, the loops and the 10 essentials are explained, created motivation and understanding of the urge to change from a linear to a circular thinking, but did not develop specific skills and competences themselves. Teaching specific techniques with particular examples and practices helped students to develop specific skills. We suggest to build on both approaches, a broad and theoretical approach and application of specific techniques. More experiences are needed to achieve effective CE teaching in the classroom. Till today, the concept of Circular Economy is still new. We will continue reflecting on the upcoming teaching experiences. Training materials are available at http://www.katche.eu/circular-economy/training-materials/, together with relevant references, stakeholders and a knowledge hub for sharing relevant information, news and experiences.

References

1. Rockström J, Steffen W, Noone K, Persson Å, Chapin F. S, Lambin III, E, Lenton T. M., Scheffer M., Folke C, Schellnhuber H, Nykvist B, De Wit CA, Hughes T, van der Leeuw S, Rodhe H, Sörlin S, Snyder P.K, Costanza R, Svedin U, Falkenmark M, Karlberg L, Corell R.W, Fabry VJ, Hansen J, Walker B, Liverman D, Richardson K, Crutzen P and Foley J. Planetary boundaries: Exploring the safe operating space for humanity. Ecology and Society 14(2), 2009.
2. Ellen Macarthur Foundation (2012) Towards the Circular Economy: Economic and business rationale for an accelerated transition.
3. Analysis of training needs, state of the art, trends and policies. In KATCH-e. WP2. Situacion analysis report. Available at: http://www.katche.eu/wp-content/uploads/2018/10/SA-report-Def.pdf [Accessed 2 Apr. 2019], 2018.
4. Whalen, K. A., Berlin, C., Ekberg, J., Barletta, I., and Hammersberg, P. 'All they do is win': Lessons learned from use of a serious game for Circular Economy education. Resources, Conservation and Recycling, 135, 335-345, 2017.
5. Whicher, A., Harris, C., Beverley, K., and Swiatek, P. Design for circular economy: Developing an action plan for Scotland. Journal of cleaner production, 172, 3237-3248, 2018.
6. Rocha, C., Camocho, D., Alexandre, J., Schmid, K., Bundgaard, A. Hirsbak, S., Celades, I., Ros, T., Oliveira-Barros, F., Atin, E., Hernáez, O., Pamminger, R., Schmidt, S., Mulet, E., Ruiz, L., Chulvi, V., Afonso, A., Sampaio, J., Kalleitner-Huber, M., Lindenthal, J., Meissner, M. and Lechner, R. Overview of the KATCH_e Modules and Tools. [online] Available at: http://www.katche.eu/wp-content/uploads/2019/02/KATCH_Modules_Tools_OVERVIEW.pdf [Accessed 2 Apr. 2019], 2019.
7. Savery, J. R. Overview of problem-based learning: Definitions and distinctions. Interdisciplinary Journal of Problem-based Learning, 1(1), 9-20, 2006.
8. Schmidt K, Bundgaard A, Hirsbak S, Rocha C, Oliveira-Barros F.M. Product-Service Development for Circular Economy and Sustainability Course. Introduction. http://www.katche.eu. 2019

C-6

University-Enterprises: a win-win relationship, from business to research

Ana M Beltrán[1]*, Paloma Trueba[1], Nuria Salan[2]**, José M. Bayo[1,3], José A. Rodriguez-Ortiz[1], Yadir Torres[1,*]

[1] Departamento de Ingeniería y Ciencia de los Materiales y del Transporte, Escuela Politécnica Superior, Universidad de Sevilla, Seville (Spain)
[2] Departament de Ciència dels Materials i Enginyeria Meetal·lúrgica, ESEIAAT, Universitat Politècnica de Catalunya (Spain)
[3] Empresa de Ingeniería: CT-Ingenieros, Seville (Spain)
*Abeltran3@us.es **nuria.salan@upc.edu

Teaching at University is always a difficult task because it implies too much theoretical lessons while students ask for practical knowledge and Enterprises claim for good junior professionals. Finding an equilibrium among all the interests is challenging but at the same time, it is the key of success. This work shows the experience of teaching in collaboration with companies to achieve a more practical and attractive approach to day-to-day Engineering work while meeting teaching objectives. It is a win-win relationship since it motivates students because they see the direct relationship between their studies and the future job; it also helps teachers to know the knowledge required by engineering companies and, besides, enterprises will have future engineers better trained, already familiar with process and tools. Furthermore, it also increases the collaborations between University and enterprises, which is key to innovate and develop new business models.

Introduction

Human capital is the most important asset of a company, because it is what really contributes to the progress of the company, to the development of innovation and productivity within the company. To this end, the degree of training of new workers must be adequate for the performance of the task entrusted to them. Training future engineers is a complex task because of the difficult to find an equilibrium between theoretical and practical teaching. Focusing on technical bachelors, it is quite challenging due to different aspects. On the one hand, students need to learn basic (theoretical) concepts and, on the other hand, they also require more practical learning. In most of the cases, students do not find the relationship between what they learn at the University and their future job.

For instance, in Spain, the new study programs of Engineering Degree are organized into three large blocks:

a) Basic subjects common to the different Engineering branches: Mathematics, Physics, Chemistry, Graphic Expression, Computer Science and Business.
b) Subjects of a common nature in the industrial branch: Energy Engineering and Heat Transfer, Fluid Mechanical Engineering, Materials Engineering, Electrical Technology, Industrial Electronics, Industrial Automation, Machine and Mechanism Theory, Material Resistance, Structures, Manufacturing Processes, Projects.
c) Subjects of a specific nature for each branch of engineering.

The aim of this division is to satisfy the competences required by the current educational system, but it does not answer to descriptors as it happened before. In spite of the fact that these study programs have already been active for more than 5 years, it is still a problem for teachers, and it is very difficult to go deeper into many aspects and trust in the autonomous work of the student. This is also a great difficulty for students who, on many occasions, do not find a direct relationship between what they learn and the future job, considering their formation very theoretical and/or far from the true work of an engineer.

Faced with this situation, teachers attempt to use new learning methodologies to adapt themselves to the study programme, while at the same time trying to satisfy students' concerns. It means to prepare students for their professional future, whether they want to develop their career in business or in research.

On the other hand, companies receive the engineering graduate, who contributes with his newly acquired theoretical knowledge. It is the companies that must update this knowledge and adapt it to the needs as well as teaches them the necessary tools to complete the training for a fully-integration in the competitive labour market. Companies usually assume this training period during the first employment contracts, which usually last a few months and have low economic remuneration, with the intention of improving working conditions as the graduates complete this training period and increase their productive value for the companies. This implies a large economic investment on the part of the company. For that reason, the possibilities of practices of companies, suppose a help for the companies since they do not have to invest a lot of resources in the formation. University-Company interaction is a win-win relationship since, on the one hand, it helps students to motivate them and see the relationship between what they study and the final work they are going to do in the future, it gives them visibility on the possibilities to channel their future, on the other hand, it helps the company so that the new incorporations have already had an approach to a work process and to the tools they have to use, minimizing the training time in the company and, therefore, increasing its productivity.

This work presents the experience of teaching in collaboration with companies to achieve a more practical approach to teaching that is attractive to students while meeting teaching objectives. This initiative is being carried out at the *Escuela Politécnica Superior de Sevilla* (EPS) [1] of the Universidad de Sevilla (US), given its vocation to train engineers through study, teaching and research, with undergraduate, master's and doctoral training projects, committed to the comprehensive training of people in collaboration with *Escola Superior d'Enginyeries Industrial, Aeroespacial i Audiovisual de Terrassa* (ESEIAAT) [2] of the Universitat Politècnica de Catalunya (UPC).

Results and Discussion

Under this situation, this need for specific training of graduates and aware of the limitations that are found in the current study programs, EPS-US is performing different actions to try to satisfy the requirements of the students and the enterprises for the integration of graduates in the workplace. Furthermore, the present working environment does not only require technical knowledge, but also professionals with good personal skills are sought to develop their skills such as responsibility, leadership, teamwork, etc. Starting from this premise, the company sets itself the aim of developing these skills while, at the same time, making it necessary to acquire specific technical training, directly related to new technological advances, as well as analysis tools, which are developed thanks to the technical base acquired in university training.

The collaboration among EPS and companies is not limited to the traditional internship [3], but rather outsourcing activities are encouraged with a less individual approach than the practices. About these activities, it is worth highlighting:

a) Collaboration through productive activities, such as agreements in research and development and innovation activities, promoted by regional institutions for researching.
b) Creation of forums for interaction between university and business, involving business within university spaces both in teaching and in visibility activities (forums, congresses, conferences).

Among the activities planned by the EPS-US concerning graduates with a business profile, during the last two years the *Business Internship Days* have been held in this center to encourage collaboration. In this activity, different engineering companies present their business with a very participative environment where students have the possibility to ask questions, doubts. Besides, these talks, the companies have stands for a closer and more direct contact to the students. In this way, the real daily of engineering is known as the same time that students can meet different companies, areas, being able to orientate their training towards those sectors or companies that are most interesting for them. Furthermore, a considerable number of the speakers participating in these days have been former students of the EPS, who either in their stage of students were motivated to this encounter with companies or missed it and wanted to contribute to meeting these needs. In both cases, the participation in these tasks is very positive and enriching, both from the point of view of the companies and from the point of view of attracting students who can join their staff in the immediate future.

In addition, some companies also hold specific seminars throughout the course to showcase their work and the role of future engineers in these enterprises. These seminars also allow them to get closer to the reality of their future jobs, emphasizing the multidisciplinary training and collaboration with different areas, as it has been shown with the participation of different departments of the same company. This is, therefore, a process that enriches itself over time and makes it increasingly interesting for students, companies and the university itself, as professors are aware of the real usefulness of the teaching program they teach.

This relationship University-Enterprise is not only a way to contribute to a more practical training of future engineers, but it also promotes researching in companies. This approach to the School of Engineers, to the University, allows them to get in touch to research topics and to establish collaborations. It is very positive for those students with a more scientific profile, since they can know the true meaning of Research & Development in Engineering companies. However, despite this increase of collaborations in terms of researching, there is still a huge lack of PhDs working in companies. In this sense, initiatives such as the *Industrial PhD*, a university training program that combines the profile of researcher and engineer, in which the bulk of the research is carried out in a company. It can be considered as a proper transfer of knowledge, presenting a double advantage, since it increases the connection of the University with the production and encourages to researchers to change their focus of research to adapt to a complex problem of the company and obtain resources [4]. In this way, the PhD student achieves the best of the academy and company: publications, doctorate degree and, at the same time, knowledge at the most cutting-edge in the professional world of the sector and the dynamic of a real engineering company. It must be improved mechanisms for transferring knowledge to business environments, to benefit from the leading position of the research model and innovation training system. Industrial PhD is not only an opportunity for graduates but also for Engineers, who are already working on a company and, thanks to this close relationship University-Company has decided to become PhD, taking profit from their knowledge acquired in their work as engineers.

Conclusions

In summary, the University-Enterprises training collaboration allows students to get closer to the reality of work and the exercise of their profession as future engineers, highlighting the multidisciplinary training and collaboration with different areas. It is a win-win relationship, since it motivates students and they see the direct connection between the studies and the final work they are going to carry out and, furthermore, it helps the company so that the new incorporations have already had an approach to the required work process and tools, making the new engineer productive in a very short period of time, which translates into profits for the company. Besides, it is also a great contribution to research and knowledge transfer since it helps companies to know and understand how University works and how to contribute to progress, integrating research into the day-to-day work of the business world.

References

1 https://eps.us.es/

2 https://eseiaat.upc.edu/

3 Secretariado de prácticas de empresa y empleo. Universidad de Sevilla, http://servicio.us.es/spee/node/32

4 Francesc Solé Parellada, vice-president of the CyD Foundation and professor emeritus of the Universitat Politècnica de Catalunya-UPC-BarcelonaTECH

C-7

Students as Stakeholders: When Future Leaders become the Leaders of now

Samira Kakh[1]*, Barnaby Pace[2]

[1] Lecturer, Applied Arts, Australian Technical and Management College New Zealand (ATMC-NZ)
[2] Head of Department, Postgraduate Studies and Research,
Otago Polytechnic Auckland International Campus (OPAIC)
*samira.kakh@atmc.ac.nz

We, at OPAIC, believe that postgraduate studies play a significant role in shaping the quality of education leadership in contemporary world. OPAIC fundamentally plans its practices based on a rather concrete network of global and contextualized values and principles, but at the same time has an agile approach to education in 21st century. This reflective work discusses the philosophy central to OPAIC approach to its methods of work particularly with regards to postgraduate students in the field of management and leadership. This philosophical approach has contributed greatly to the advancement of our sustainability plans and teaching standards. We managed to accumulate features suggested by our students, which ended up becoming a backlog of features that our internal education system needed to contain. This backlog has been pushing us to facilitate the acquisition of knowledge not via "teaching" leadership to students through courses, but through involving students in developing and planning academic outputs.

This reflective work uniquely contextualizes the concept of novice researchers into the interaction between academic staff and their new international postgraduate students and its effect on their identity development as inspired individuals who wish to enter the community of practice in the field of management and leadership. Here, firstly non-deceptive plagiarism will be revisited to shed light on prospective students' source-use abilities and discuss the academic integrity expectations at Anglo-western educational institutions. Then, a reflection on how source use and the issues surrounding language appropriation are communicated to students and whether and to what extent students benefited from the information. This reflective work is an argument that justifies the importance of compulsory academic literacy workshops prior to entering tertiary programmes for addressing the identity building needs of international students to be able to take on new socially-constructed roles.

An important aspect of getting oriented into a program is communicating the rules governing conduct in academia in general and OPAIC in particular. It is the responsibility of the heads of departments to unpack the whole concept of 'the ownership of idea' from an ethical and integrity perspective for new students in an orientation week introductory workshop. It is particularly important for students to hear rules, principles, procedures of dealing with plagiarism cases, and the government's perspectives from managers. For instance, associating immorality of plagiarism (and all its forms such as buying assignments and receiving unauthorized assistance) with managerial power transmits a strong message about integrity of academic practice and school expectations to students. Ultimately, the purpose of such specific communication is making it clear for students that we, as the gatekeepers of the world of science, look at our students beyond what they produce and submit; and therefore, our responses to flawed aspects of assignment production is firm and policy oriented.

But like a coin, our practice has two sides. On one side, it is engraved that integrity is the soul of our practices, on the other side we see our motto: "I'm capable". We'd like our students to showcase the acquisition of learning outcomes through successful performance. To this aim, we had to move from superficial concerns such as preventing 'poor paraphrasing', 'APA noncompliance', 'unfocused texts' to scaffolding the process of learning how to construct solid arguments and display informed judgements. So, if we want to illustrate the point of difference between OPAIC and many other institutions, it would suffice to say that while 'the instructions about plagiarism' that other places are offering is in the form of warnings and a section in Student Handbooks, we have designed orientation workshops and keep modifying them based on students' needs and suggestions as well as our own experiences to put what we do outside the framework of common practices. While others are guiding their students to produce plagiarism-free assignments, we are supporting students by crafted workshops to develop critical and analytical minds, believing that 'thinking' leads to 'discovery' and 'awareness'.

The overarching purpose of the orientation workshops is to walk our new PG students through the linguistic phenomenon that is embedded in all the activities that they are required to do. A great deal of activities that students and facilitators do in orientation workshops are not around the act of language use and writing using sources. The idea that there is a trajectory in academic writing skill development is fact-based and the suffering and the blood and tears are real; nonetheless, a 16 hour orientation workshop does not have that superpower to make new international postgraduate students acquire the skill set that native speakers usually gain all the way through school, high school, and their undergrad. Luckily, there is always better ways outside the box of norm, in our case it is embracing our students as contributing stakeholders. In the following paragraphs, three students reflected on their experiences of starting their postgraduate studies at OPAIC and getting involved in designing workshops.

"I started my Postgraduate studies in NZ, in October 2018. Looking back at the orientation and assessment workshop, I can see a 'journey' that I was taken on and was asked to lead. Wining postgraduate excellence award a couple of weeks ago for my performance last block as well as the confidence that I have right now in finding materials, expanding my knowledge about my areas of interest independently means nothing but I have managed to develop an integrated identity by articulating what would help me in the process of learning and development. The identity that I brought with myself from my home country as an entrepreneur, the identity that I developed as an independent student and learner at OPAIC, the identity that I developed as an international student who has a word and can criticize or fairly praise the system, and an identity as an academic who can critically evaluate and analyze information. For me, being able to describe the standards for academic writing and assignments is simple; what I have learned from the workshops that I attended is developing an authentic voice for myself that I can talk about it and justify it." – Artem Voynov

"I started my studies at OPAIC in January 2019 and attended all Academic Literacy workshops and Research and Enquiry classes. What I asked my lecturer to discuss in the class and to facilitate our learning about was understanding how to construct academic arguments. What I learned so far is that arguments are made of language. In other words, arguments are made of a series of statements. Most of the time, the function of the sentences in an argument is creating an opinion. There are so many strings of sentences out there, in magazines, newspapers, books, novels, dictionaries, etc. But, these strings of sentences are not constructing arguments. The reason is: What we see every day as texts are not necessarily aiming at establishing opinions. I also learned that: Arguments are NOT always aiming at establishing opinions! Because, there are times when the opinion itself is something that we have already accepted as truth! So, the argument is not establishing that opinion! It is showing why that opinion is true. For instance, think about an argument about "why yoghurt is white!". We already know plain yoghurt is white! The argument is expected to present reasons why this opinion is true. An argument is made of some sentences, some of these sentences are reasons and some presenting the main opinion. The reasons should prove the opinion or prove why the opinion is true." – Abigail Andres

"I started my studies at OPAIC in January 2019 and attended Academic Literacy workshops and Research and Enquiry classes regularly. My initial concern was dealing with massive amount of new information and readings. I found reading excruciating, and my main reason was, not having any reading goals. I have shared my frustrations in meetings with my lecturer and expressed what I needed to learn. Consequently, we got engaged in activities through which I learned that a "literature review" is a distinctive form of research. I learned that a literature review is rigorous and not easy at all to write. Writing a literature review requires a great deal of research skills and without having insights we cannot really go further than summarizing relevant information and writing and organized piece of text. I also learned that a literature review is embedded in all the assignments that I'm doing and will do in the future and it is the most appropriate means of addressing issues and verifying opinions. I also realized that finding a research problem is the very first step in conducting many types of research. The second step is then searching and retrieving relevant literature, evaluate, synthesize, and analyze them to create new understandings." – An Do

As probably obvious from our students' reflections, the way that we particularly chose to orient new PG students is bending, offering students our back to take a leap on to the shoulders of giants. We believe superficial irrelevant language activities take our students just to the doorstep of producing texts free of plagiarism and in academic style. But facilitating evaluation, analysis, reasoning not only involves them in language activities, but brings clarity, relevance, and logic to their works. We hope this reflective work contributes to the development of a unique āwhina culture within academia by aligning academic practices to the Maori value of whanaungatanga and emphasizing on building and maintaining strong relationships between academic staff and students.

D

Engineering and development co-operation

D-1

A Sustainable Development Goal in 'Energy generation and transmission' subject

O. Ukar[1*], C. Pascual[2], I. Iraragorri[2], P. Puente[2], A. Mugica[1]

[1] University of Deusto

[2] ICLI- Ingeniería para la Cooperación - Lankidetzarako Ingeniaritza

**olatz.ukar@deusto.es*

The Sustainable Development Goals (SDGs), are a universal call for action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity.

Universities, as agents of society, must generate and transfer knowledge according to the objectives of the 2030 Agenda for Sustainable Development.

In this article, an example of good practices to work towards the SDGs, in particular of number 7: Affordable and clean energy in the university is presented.

Introduction

The General Assembly of the United Nations adopted in September 2015 the 2030 Agenda for Sustainable Development. This Agenda is a call for action by all countries – poor, rich and middle-income – to promote prosperity while protecting the planet. The member states of the United Nations adopted a resolution in which they recognize that the greatest challenge in the world today is the eradication of poverty and they affirm that without achieving it there cannot be sustainable development. They recognize that ending poverty must go hand-in-hand with strategies that build economic growth and address a range of social needs including education, health, social protection, and job opportunities, while tackling climate change and environmental protection.

The 2030 Agenda for Sustainable Development proposes 17 Sustainable Development Goals with 169 integrated and indivisible goals that cover the economic, social and environmental spheres.

The 2030 Agenda represents a great opportunity for the change demanded by the entire Society. Universities should be the key space to generate this transformation process. Since the approval of the Sustainable Development Goals (SDGs) by the United Nations in September 2015, Spanish universities have assumed an active role in fulfilling the 2030 Agenda and have incorporated the principles and values of Sustainable Development into their objectives, policies and university activities.

The University, as an agent of society, must generate and transfer the knowledge and innovation necessary to respond to the complex challenges of Sustainable Development. That is why in the Energy Generation and Transmission subject of the master's in industrial engineering it has been decided that in addition to the competences established by the legislation, work the SDGs and the particular the 7th which is the one that is most aligned with the subject. In this paper how this connection has been made is explained.

Methodology

Brief description of the subject

The 'Energy Generation and Transmission' subject is a 9ECTS subject of the first year of Master's in industrial engineering. The Master's in Industrial Engineering is an official master's degree that qualifies students to practice as Industrial Engineers.

The teaching-learning model in this master is based is the Deusto Education Model. This teaching model promotes meaningful self-directed learning, fostering students' all-round development (personal, social, ethical, academic and professional dimensions). The teaching methodology is focused on developing the practical aspects of Industrial Engineering using leading-edge techniques.

The 23 specific competences of the Master's in Industrial Engineering are established by the current legislation CIN/311/2009. The two specific competences developed in 'Energy Generation and Transmission' subject are:

- Knowledge and capacity for the analysis and design of electricity generation, transport and distribution systems.
- Knowledge and skills that allow understanding, analyze, exploit and manage the different sources of energy.

According to these two skills and related to the 7th SDG a project based learning activity has been proposed in this subject with the NGO Engineering for Cooperation-ICLI ("Ingeniería para la Cooperación - Lankidetzarako Ingeniaritza"). Engineering for Cooperation

ICLI NGO is a non-profit association, which integrates Engineers and Industrial Engineers and any other person who wishes to collaborate in tasks of cooperation and development assistance. It aims to promote actions that help developing disadvantaged areas, trying - at the same time - to channel and promote the concerns that this line has the Industrial Engineering collective and society in general, as well as to involve other social agents in this homework.

Proposed activity

The challenge that students have to face is to develop a project aimed at improving the life of a community located in a Developing Country.

For this, in a first session where the general conditions of development of a specific case are presented and the problem to be solved will be exposed.

The group of students is divided into 2 groups. Each of the groups will have to solve a single project. This project consists in "improving the life of an agricultural community through the maximization of tomato production", which requires at least 3 technical developments that must be coordinated among themselves to achieve a viable and sustainable solution. For this they must respond to the following requirements.

On the one hand it is necessary to achieve energy generation (solar and / or wind), to illuminate the workspace, during the hours when there is no natural light.

On the other hand, they must respond to the demand for energy to maximize the production of tomatoes, where they must choose to automate a ventilation system, which can be natural or forced and / or cool the greenhouse where the tomatoes are harvested. And finally, they must also heat the shower water for the hygiene of the 4 people who work in the production of tomatoes.

For all this they have a maximum budget of $ 25,000

Students must prepare a report of the project and make a presentation in court. The court, composed of members of the NGO and the teacher of the subject will ask the group questions, to determine the degree of compliance with the objectives. Viability and economic sustainability will be assessed, as well as the technical solution adopted.

Conclusions

All of us must become agents of change by acquiring knowledge, skills, values and attitudes that empower them to contribute to sustainable development, to achieve a more sustainable world and to fulfill all the goals set out in the SDGs.

Thus, to achieve this type of development, learning processes are crucial. The University understood as a key agent in the process of transformation towards sustainability. The inclusion in the university curriculum of the promotion of sustainable development and implementing active methodologies in the classroom, aims to train students in transversal competences. In this way, the SDGs can be achieved and ensure that all students acquire the knowledge, both theoretical and practical, necessary to promote sustainable development.

References

1. United Nations. https://www.un.org/sustainabledevelopment/sustainable-development-goals/
2. CRUE, Sectorial Sostenibilidad. http://www.crue.org/SitePages/Crue-Sostenibilidad.aspx
3. NGO ICLI. http://www.icli.info/es/
4. SDSN Australia/Pacific (2017): Getting started with the SDGs in universities: A guide for universities, higher education institutions, and the academic sector. Australia, New Zealand and Pacific Edition. Sustainable Development Solutions Network – Australia/Pacific, Melbourne.

E

Environmental sustainability

E-1

Analysing the incorporation of Sustainable Development into European Higher Education Institutions' curricula

Rodrigo Lozano[1,2], María Barreiro-Gen[1]*

[1] Faculty of Engineering and Sustainable Development, University of Gävle, Kungsbäcksvägen 47, 80176 Gävle, Sweden

[2] Organisational Sustainability, Ltd. 40 Machen Place, Cardiff CF11 6EQ, UK

**maria.barreiro@hig.se*

Introduction

During the last decade, there has been an increase in sustainable development (SD) integration into Higher Education Institutions (HEIs) (Boks & Diehl, 2006; Wemmenhove & de Groot, 2001), where European HEIs have been leaders in this process (Disterheft, Ferreira da Silva Caeiro, Ramos, & de Miranda Azeiteiro, 2012; Karatzoglou, 2013). Integrating SD into curricula has been recognised to be instrumental in providing students with the skills and insights to help societies become more sustainable (R. Lozano, 2010) and provide companies with graduates who are sustainability literate (as highlighted by the WBCSD, 2010).

Several tools have been developed, or modified, to assess SD in universities. One of the few tools focusing specifically on curricula is the "Sustainability Tool for Assessing UNiversities' Curricula Holistically" (STAUNCH®). Curricula assessment can provide an overview on how courses and programmes incorporate SD (Lozano, 2010; Lozano & Peattie, 2011; Stough, Ceulemans, Lambrechts, & Cappuyns, 2018). STAUNCH® was developed with the aim of assessing holistically and systematically how a university's curricula contributes to SD (*i.e.* the SD issues' coverage, depth and breadth) (R. Lozano, 2010; R. Lozano & Peattie, 2011). STAUNCH® is based on two combined equilibria: firstly, cross-cutting theme issues (such as Holistic thinking, and SD statement, see Table 1), which integrate economic, environmental, and social dimensions; and secondly, the SD contribution, which is calculated using formulae that look for the balance among the four dimensions, taking into consideration their strengths. These are assessed using the following levels:

0, when an issue is not mentioned; 1, the issue is mentioned but there is no further explanation given on how it is addressed; 2, the issue is mentioned and there is a brief description of how it is addressed; and 3, there is a comprehensive and extensive explanation on how the issue is addressed.

Table 1. STAUNCH® curricula contribution to sustainable development assessment criteria

Economic	Environmental	Social
• GNP, Productivity • Resource use, exhaustion (materials, energy, water) • Finances and SD • Production, consumption patterns • Developmental economics	• Policy/Administration • Products and services (inc. transport) • Pollution/Accumulation of toxic waste/Effluents • Biodiversity • Resource efficiency and eco-efficiency • Global warming, Emissions, Acid rain, Climate change • Resources (depletion, conservation) (materials, energy, water) • Desertification, deforestation, land use • Ozone depletion • Alternatives	• Demography, Population • Employment, Unemployment • Poverty • Bribery, corruption • Equity, Justice • Health • Social cohesion • Education • Diversity • Cultural diversity (own and others) • Labour, Human rights
Cross-cutting themes		
• People as part of nature/Limits to growth • Systems thinking/application • Responsibility • Governance • Holistic thinking • Long term thinking • Communication/Reporting • SD statement • Disciplinarity • Ethics/Philosophy		

Source: (R. Lozano, 2010; R. Lozano & Peattie, 2011)

This paper assesses the SD incorporation into European HEIs' curricula. The paper is structured in the following way: Section 2 presents the methods used; Section 3 focusses on the results and Section 4 presents the discussion and conclusions.

Methods

A survey was developed to investigate teaching SD competences in European Higher Education Institutions. The survey consisted of six sections:

1. Background questions about the respondent's HEIs, the respondent characteristic, and her/his teaching (in general and SD);
2. Self-assessment of SD criteria taught, based on the STAUNCH® criteria, and on a four scale (not covered, mentioned, described, and discussed);
3. Pedagogical approaches used, on a five scale (never, seldom, from time to time, often, and all the time);
4. Competences covered in the course, on a five scale (not at all, mentioned, discussed, complementary to the course, and integral to the course);
5. Types of learning, on a five scale (never, seldom, from time to time, often, and all the time); and
6. Open ended questions about the incorporation of SD in courses.

This paper focuses on sections 1 and 2. The survey was applied using the online survey tool SurveyMonkey (2019). The survey was open for three months from September to December 2018. The survey was sent to a database of 4,099 contacts in Europe obtained from conference participation, articles published on SD in leading HESD journals, and personal contacts. In addition, 44 anonymous links were sent out through Linkedin®. Three reminders were sent out. From the total list of emails, 164 emails bounced back, 1,962 open the email invitation (48.9%), and 1,822 did not open it (45.4%). From these, 392 total responses were obtained (9.85%) for the self-assessment of SD part. The responses were analysed using descriptive statistics, t-test, and ANOVA (see Jupp, 2006). These were done with IBM SPSS 25 (IBM, 2016). All tests were done at $p<0.05$, unless specified in brackets.

Results

From the 392 responses, 220 were male, 165 female, and 7 preferred not to say. 97 respondents had been teaching for more than 20 years, 123 between 10 and 20 years, 90 between 5 and 10, 71 between one and 5, 7 less than a year, and 4 did not answer the question. 362 respondents indicated that they teach SD in their courses, 27 do not teach it, and 3 did not respond; 146 in Masters, 134 taught only in Bachelors level, 81 in Bachelors and Master levels; 24 in PhD or PhD combined with Bachelors and/or Master; and 7 did not answer.

The contribution to SD was on average 5.84, a standard deviation of 7.24, a maximum of 69.89, and a minimum of 0.67. The average strength was 1.88 with a standard deviation of 0.41. The results highlighted that the social dimension was the least addressed with 18%, while the other dimensions (economic, environmental, and cross-cutting) were addressed almost equally at between 27% and 28%.

Differences in means

This section presents the differences in means (using t-tests and ANOVA) of gender, education level, and countries. The tests did not show any statistically significant differences in the type of HEIs.

a. Means differences in gender

A t-test was carried out between female and male respondents to test the differences in means. There were no significant differences in the contribution, economic dimension, or environmental dimension. There were differences in the social dimension and cross-cutting themes, where the means for female respondents (10.324 and 15.622) were higher than that of males (8.814 and 14.032), respectively. The differences in the indicator showed that women had a higher mean in, with the difference in brackets:

- Cross-cutting themes: Holistic thinking (0.332); People as part of nature/Limits to growth (0.330); Responsibility (0.271); Communication/reporting (0.264); and Sustainable development statement (0.206);
- Social dimension: Cultural diversity (own and others) (0.270); Poverty (0.265); Health (0.221); Employment/unemployment (0.212); and
- Environmental dimension: Biodiversity (0.233) and desertification, deforestation, and land use (0.202).

b. Means differences in Education level

An ANOVA was done to test the mean differences between four groups: 1) Bachelors; 2) Masters; 3) Bachelors and Masters; and 4) PhD or PhD combined with Bachelors and/or Masters.

There were statistical differences according to the level where the courses were being taught. Bachelors had a lower mean than Masters, and Bachelors and Masters in: Social (with p=0.018 and p=0.092 respectively); Cross-cutting themes; Resource use, exhaustion (materials, energy, water); Policy/Administration; Products and services (inc. transport); Biodiversity; Systems thinking/application; Governance; and Holistic thinking.

Bachelors had a lower mean than Bachelors and Masters and PhD or PhD combined with bachelors and/or masters in: Desertification, deforestation, land use. Bachelors had a lower mean than bachelors and masters in: Economic; Poverty (with p=0.072); Equity, Justice; People as part of nature/Limits to growth (with p=0.060); and Sustainable development statement. Bachelors had a lower mean than Masters in Diversity (with p=0.056); Communication/Reporting; and than PhD or PhD combined with bachelors and/or masters in Bribery, corruption (with p=0.073). Bachelors and masters had a lower mean than masters in disciplinarity (with p=0.087).

c. Means differences in countries

The respondent were from Italy (19.79%), Spain (14.91%), Sweden (10.54%), Netherlands (5.66%), United Kingdom (5.40%), Finland (4.63%), Portugal (4.63%), Germany (3.60%), Austria (2.83%), Poland (2.83%), Denmark (2.57%), Turkey (2.57%), France (2.31%), Czech Republic (2.06%), Greece (2.06%), Serbia (2.06%), Switzerland (1.54%), Belgium (1.29%), Lithuania (1.29%), Norway (1.29%), Ireland (0.77%), Slovenia (0.77%), Croatia (0.51%), Hungary (0.51%), Iceland (0.51%), Romania (0.51%), Albania (0.26%), Cyprus (0.26%), Malta (0.26%), Slovakia (0.26%), and no answer (1.54%).

The differences between five countries were analysed, since there were enough data points to compare them: Italy (19.79% of all the respondents); Spain (14.91%); Sweden (10.54%); Netherlands (5.66%); and United Kingdom (5.40%). The contribution level showed that the mean was higher in the Netherlands (8.624), followed by Sweden (8.512), United Kingdom (5.855), Spain (4.440), and Italy (3.476). The SD strength differences were: Sweden (2.083), United Kingdom (1.919), the Netherlands (1.980), Spain (1.691), and Italy (1.724).

For the SD dimensions the differences were:

- Economic: Sweden (16.727), United Kingdom (16.029), the Netherlands (15.873), Italy (12.904), and Spain (12.072);
- Environmental: Sweden (17.473), United Kingdom (15.514), the Netherlands (14.891), Italy (11.373), and Spain (10.583);
- Social: Sweden (13.171), the Netherlands (10.860), United Kingdom (10.597), Spain (7.914), and Italy (6.110); and
- Cross-cutting themes: Sweden (19.383), the Netherlands (18.123), United Kingdom (16.113), Spain (11.079), and Italy (10.484).

Discussion and conclusions

This research highlights a number of phenomena happening in European HEIs' courses where SD is taught. Firstly, the analyses showed that teaching in European courses covers many issues of sustainability in a fairly good balance, with the exception of social issues, which although they are important and correlated to the other dimensions, they are the least addressed (18% against around 27% of the other dimensions).

Secondly, females tend to more teach SD in a more balanced way than men, which may be linked to their higher awareness and interest in SD (see Haartman, Sammalisto, Lozano, & Blomqvist, 2017; Zelezny, Chua, & Aldrich, 2000).

Thirdly, the HEIs types does not really have any influence on how SD is being taught, but the education level has. In general, Bachelors courses tend to contribute less to SD, followed by Masters and then by teaching in combination of levels.

Fourthly, some countries, in the case of this research Italy and Spain, may show more interest (with a combined response rate of around 35% of the sample), yet their means tended to be lower than those others, in this research Sweden, United Kingdom, and the Netherlands (which were around 20% of the respondents). This may indicate that there is a will to advance in SD teaching.

The paper presents one of the first analyses of SD teaching in European HEIs. The research shows that SD has to be addressed holistically. SD educators should share their experiences teaching it, so it can delivered it more efficiently to their students. This should be done across disciplines, gender, education levels, and countries, in order to provide students with the skills and insights to help societies become more sustainable. SD teaching has increased in the last two decades. Curricula assessment showcases how SD is being incorporated into courses and programmes, and lead to more literate students who are better prepared for the sustainability job market and in making societies more sustainable.

Further research should be carried out in whole institutions, where preferably all educators assess their contribution to SD, whether they teach it or not.

References

Boks, C., & Diehl, J. C. (2006). Integration of sustainability in regular courses: experiences in industrial design engineering. *Journal of Cleaner Production*, *14*(9–11), 932–939.

Disterheft, A., Ferreira da Silva Caeiro, S. S., Ramos, M. R., & de Miranda Azeiteiro, U. M. (2012). Environmental Management Systems (EMS) implementation processes and practices in European higher education institutions – Top-down versus participatory approaches. *Journal of Cleaner Production*, *31*, 80–90. http://doi.org/10.1016/j.jclepro.2012.02.034

Haartman, R. Von, Sammalisto, K., Lozano, R., & Blomqvist, P. (2017). A Longitudinal Comparison of Sustainability Learning between Men and Women in Engineering and Nursing Programmes. *Sustainability*, *9*(8), 1464. http://doi.org/10.3390/su9081464

IBM. (2016). SPSS software.

Jupp, V. (2006). The SAGE dictionary of social research methods. London: SAGE publications.

Karatzoglou, B. (2013). An in-depth literature review of the evolving roles and contributions of universities to Education for Sustainable Development. *Journal of Cleaner Production*, *49*, 44–53. http://doi.org/10.1016/j.jclepro.2012.07.043

Lozano, R. (2010). Diffusion of sustainable development in universities' curricula: an empirical example from Cardiff University. *Journal of Cleaner Production*, *18*(7), 637–644. http://doi.org/http://dx.doi.org/10.1016/j.jclepro.2009.07.005

Lozano, R., & Peattie, K. (2011). Assessing Cardiff University's Curricula Contribution to Sustainable Development Using the STAUNCH(RTM) System. *Journal of Education for Sustainable Development*, *5*(1), 115–128. http://doi.org/10.1177/097340821000500114

Stough, T., Ceulemans, K., Lambrechts, W., & Cappuyns, V. (2018). Assessing sustainability in higher education curricula: A critical reflection on validity issues. *Journal of Cleaner Production*, *172*, 4456–4466. http://doi.org/10.1016/j.jclepro.2017.02.017

SurveyMonkey. (2019). Survey Monkey. San Mateo, California, USA.

WBCSD. (2010). *Vision 2050. The new agenda for business*. Geneva, Switzerland, Switzerland.

Wemmenhove, R., & de Groot, W. T. (2001). Principles for university curriculum greening. An empirical case study from Tanzania. *International Journal of Sustainability in Higher Education*, *2*(3), 267-283.

Zelezny, L. C., Chua, P.-P., & Aldrich, C. (2000). New Ways of Thinking about Environmentalism: Elaborating on Gender Differences in Environmentalism. *Journal of Social Issues*. http://doi.org/10.1111/0022-4537.00177

E-2

Mobility Needs in the University of the Basque Country and their Environmental Footprint

E. De la Torre*, G. Bueno, I. Zuazo, E. Saez de Camara, U. Tamayo
University of the Basque Country UPV/EHU
*eduardo.delatorre@ehu.eus

Introduction

EHU-Aztarna is a project performed by a transdisciplinary team of professors, researchers, administration and service staff and students of the University of the Basque Country (UPV/EHU). It aims to calculate the Organisational Environmental Footprint (OEF) of the UPV/EHU in order to monitor and communicate to the university community our performance. EHU-Aztarna is one of the projects of Campus Bizia Lab, a program arising from the Erasmus Project University Education for Sustainable Development (US4SD) for addressing the sustainability challenges at our university's three campuses by means of a cross-cutting approach involving students, administrative and academic staff [1].

OEF is a multi-criteria measure of the environmental performance of an organisation performed with a life cycle perspective (Organisational Life-Cycle Assessment, O-LCA). The benefits of the evaluation of our university's environmental footprint include the determination and quantification of the main impacts, the comparison of these impacts with the ones of other universities as well as the identification of areas for improvement. In our context, the results of the OEF will be applicable to communicate these impacts to the university community in a friendly and easy way and, to raise awareness about the need of reducing the OEF. In addition, students participate actively by making part of these tasks and lastly by carrying out their final year projects for bachelor's degrees and masters' courses, therefore, EHU-Aztarna is a high impact curricular practice.

Methodology

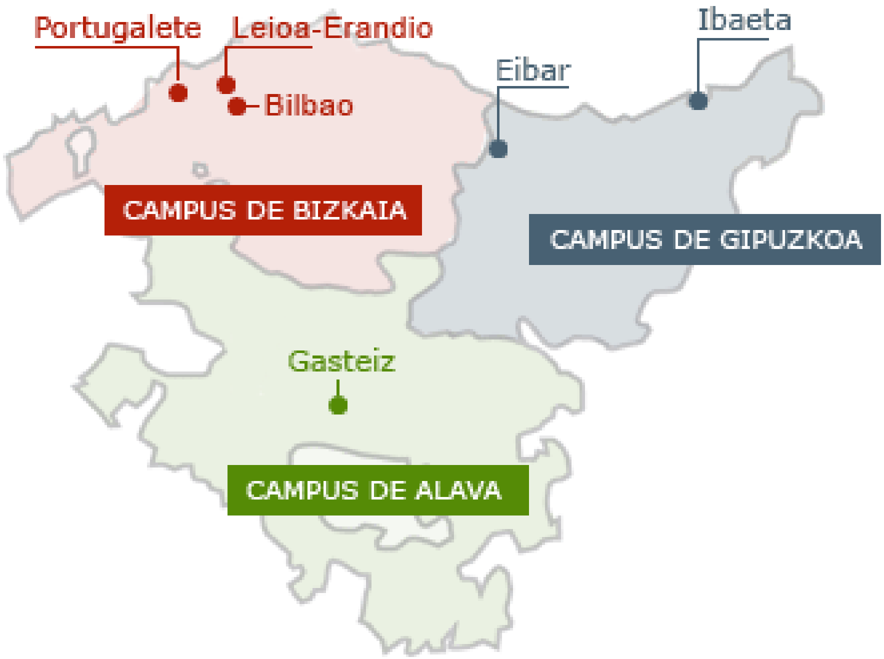
We used as a reference the OEF Guide promoted by the European Commission [2]. The analysis made in the UPV/EHU involved the collection and evaluation of inputs (consumption of materials and energy), outputs (emissions, water discharges and waste production) and impacts derived from the academic activity, including transport needs of staff and students. With regard to the last activity, universities are important poles of attraction for frequent travellers and thousands of daily trips are made towards and from European universities [3]. One of the O-LCA practical cases for academia sector published by the UN Environment report, in particular the Faculty of Science and Technology-UPH, indicated that the greatest impact is due to transport [4].

On this basis, our hypothesis is that our university's transport could be one of the main activities of negative impact on the environment. Consequently, the UPV/EHU decided to participate in the U-MOB LIFE project. The main objective of this project is the creation of a university network to facilitate the exchange and transfer of knowledge about sustainable mobility best practices among European universities. The UPV/EHU has an additional goal: to determine the footprint due to transport through better university community mobility. EHU-Aztarna is collaborating in this sense by determining the transport environmental footprint of the UPV/EHU.

The effects of mobility needs of the UPV/EHU on climate change and other environmental aspects have not been examined in detail. In order to do that, a broad mobility survey was carried out during the summer of 2018 to have an accurate understanding of mobility habits of students and employees in the UPV/EHU. The information obtained through the survey included the following points: the place where the users come from and head to, users' characteristics (genre, age and position), how long it takes them to commute (in km), main means of transport and their characteristics and how often the users commute (weekly and daily frequency). Additionally, information about displacements due to changes of residence and work displacements (e.g. congress trips or work meetings) were collected. Apart from that, previous reports of the UPV/EHU and other agents were gathered and analysed. After that, the OEF of these transport needs was calculated based on the information provided by the survey as well as these other information resources. Environmental impacts of transport were modelled using the Ecoinvent 3.3 database with CML and ReCiPe LCIA methods in openLCA software [5,6].

It should be noted that analysing and reducing the transport environmental footprint in the UPV/EHU is especially complex. The UPV/EHU has several teaching and research facilities across the Basque Country (Figure 1). Many of these are located in the capital cities -Bilbao, San Sebastian (Ibaeta) and Gasteiz- and also in Leioa-Erandio, Portugalete and Eibar. The proximity of these centres (with maximum distances of 100 km) and the wide transport offer in the Basque Country (effective highway roads and public transport) lead to a broad casuistry when students and staff commute to their centres.

Figure 1. Location of main centres in the Basque Country



Results and Discussion

Results of transport habits

A total number of 3569 people responded the survey. Gathered responses and population from 2016-2017 are shown in Table 1. The population was divided into two groups because of different mobility habits: students and staff. The estimated margin of error of the survey was less than 4% for both students and staff, for a typical confidence level of 95.5% and a maximum indetermination of the sample p=q=0.5. According to the criteria followed, these values indicate a good representativeness of the sample [7].

Table 1. Answers gathered in the survey by groups, population and margin of error

Groups of Users	Responses	Population from 2016/17	Margin of error
Students	2.966	39.018	1.7%
Staff	603	8.178	3.8%

Units of transport measurement were calculated by extrapolating survey data to one academic year and to the total population of the UPV/EHU, specifically, to passenger-kilometres (pkm), which is the unit required by Ecoinvent databases. Calculations were made for the two user groups (students and staff), for different means of transport (airplane, train, long-distance coach, urban bus, tram, metro, car, motorcycle, bicycle and by foot), and, for several types of transport (daily commuting, change of residence displacement and work displacements). Results for total transport are shown in Table 2. It is important to note that, in this paper, transport by foot is excluded due to its negligible impact on climate change.

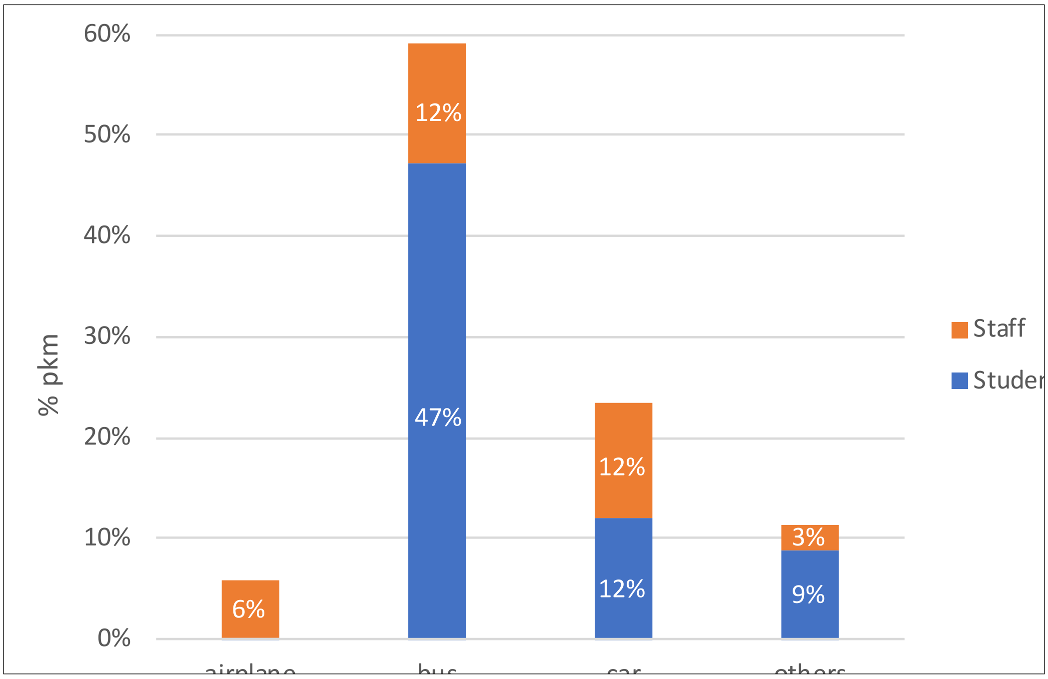
Despite the low number of staff (17 % of the university community), staff's pkm is one third of the total pkm. Additionally, remarkable differences were observed between the two groups for different means of transport: students use mainly the bus, while staff uses mainly bus and car, followed by airplane.

Table 2. Units of transport for the total population of the two user groups of the UPV/EHU

Means of transport	pkm students	pkm staff	pkm total
Airplane	4.96×10^5	2.57×10^7	2.62×10^7
Train	1.94×10^7	6.99×10^6	2.64×10^7
Bus	2.11×10^8	5.30×10^7	2.64×10^8
Tram	1.78×10^6	5.76×10^5	2.36×10^6
Metro	1.57×10^7	2.47×10^6	1.82×10^7
Car	5.34×10^7	5.17×10^7	1.05×10^8
Motorcycle	1.02×10^6	5.82×10^5	1.61×10^6
Total	3.03×10^8	1.41×10^8	4.44×10^8

The relative weight of the information in Table 2 is depicted in Figure 2. It can be seen from the figure that bus transport constitutes nearly 60% of the total transport; the main contribution from this 60% is done by students (47%). The second most used means of transport is the car, which constitutes 24% of the total transport, and in contrast to the previous one, it is equally divided between staff and students. 6% of total transport corresponds to airplane travel which is exclusively used by the staff.

Figure 2. Distribution of total transport according to passenger kilometres (pkm). Different means of transport were grouped together as 'others' because their quantity in terms of pkm are far from being significant compared to airplane, bus and car



Results of environmental impacts

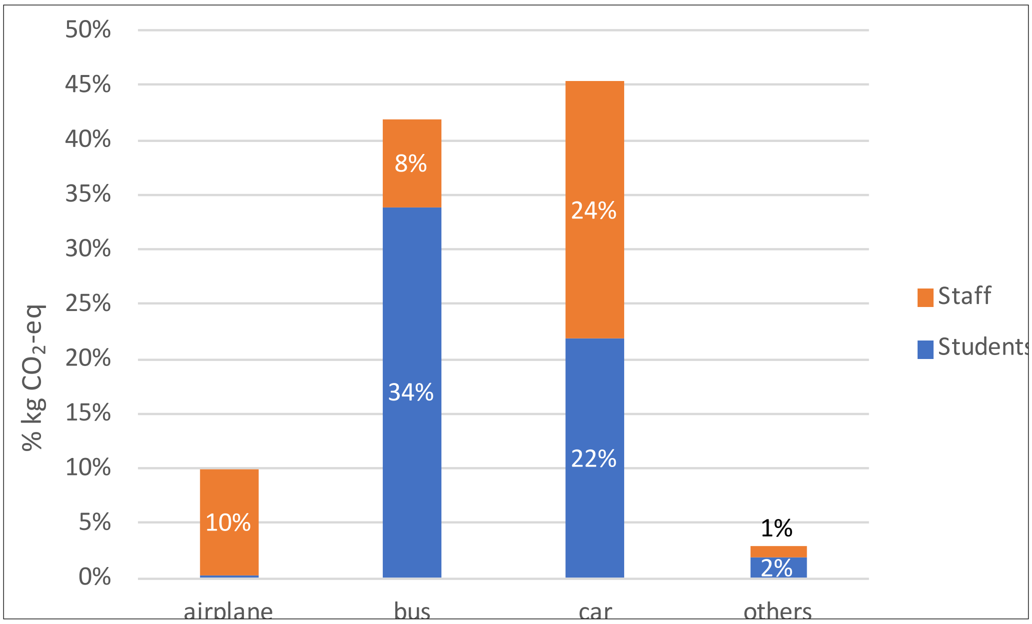
Different environmental impacts calculations were conducted following the CML baseline methodology. Impacts on climate change are addressed in Table 3. Despite the low proportion of staff compared to students (a ratio of 4.8 students per employee), the staff's impact is very significant, being only 26% lower than students' impact. A student has an impact of 544 kg CO_2-eq/person·year, whereas an employee has an impact of 1902 kg CO_2-eq/person·year. This prominent impact is due to the extended use of the car among the staff.

Table 3. Calculated transport impact on climate change for the two user groups of the UPV/EHU

Means of transport	kg CO_2-eq students	kg CO_2-eq staff	kg CO_2-eq total
Airplane	6.93×10^4	3.59×10^6	3.66×10^6
Train	2.17×10^5	2.62×10^5	4.79×10^5
Bus	1.25×10^7	2.90×10^6	1.54×10^7
Tram	1.16×10^5	3.76×10^4	1.54×10^5
Metro	1.73×10^5	2.71×10^4	2.00×10^5
Car	8.03×10^6	8.67×10^6	1.67×10^7
Motorcycle	1.29×10^5	7.35×10^4	2.03×10^5
Total	2.12×10^7	1.56×10^7	3.68×10^7

The relative weight of the information in Table 3 is depicted in Figure 3. According to the figure, car transport constitutes nearly half of the total impact (46%). This percentage contrasts to its associated pkm that corresponds only to 24% of total transport (Figure 2). The contribution from this 46% is equally divided between students and staff. The second means of transport with highest climate change impact is the bus, which constitutes 42% of the total impact, and conversely to the previous one, students are the main contributors. 10% of the total impact is due to airplane travels which are exclusively made by the staff and only represent 6% of the pkm.

Figure 3. Distribution of total transport according to climate change impacts



Conclusions

The OEF regarding the mobility of the community of the UPV/EHU with a life cycle perspective has been calculated on the framework of a program for addressing the sustainability challenges at our university. From this, we can draw several conclusions:

- In terms of distance, students commute less than staff. Students constitute 83% of the total community but they only represent two thirds of total passenger-kilometres of the UPV/EHU.
- Students use more sustainable means of transport: bus is the most used means of transport.
- Students' individual climate change impact is remarkably lower than staff's impact: 544 kg CO_2-eq/person·year vs 1902 kg CO_2-eq/person·year.

In future work it should be analysed if these habits among students results from a lack of economic resources, or if it is due to a high environmental awareness.

Acknowledgements

Financial support for this study was provided by Vice-Chancellorship for Innovation, Social Outreach and Cultural Activities of the University of the Basque Country (UPV/EHU) through a programme supported by the Basque Government. The authors would like to acknowledge the Office of Sustainability of the UPV/EHU for adapting the mobility survey to the needs of this study and for providing its results.

References

1. Campus Bizia Lab Program (2017). Available on: https://www.ehu.eus/es/web/iraunkortasuna/campus-bizia-lab Last access: April 2019
2. European Commission (2012). Organisation Environmental Footpint (OEF) Guide. Available on: http://ec.europa.eu/environment/eussd/pdf/footprint/OEF%20Guide_final_July%202012_clean%20version.pdf Last access: april 2019
3. U-MOB Life Project (2019). Available on: https://u-mob.eu/project/ Last access: April 2019
4. UN Environment (2017). Road testing organization life cycle assessment around the world. Applications, experiences and lessons learned. Available on: https://www.lifecycleinitiative.org/o-lca-road-testing-publication-launched/ Last access: April 2019
5. Ecoinvent (2016). Information on ecoinvent 3.3. Available on: https://www.ecoinvent.org/database/ecoinvent-33/ecoinvent-33.html Last access: april2019
6. openLCA. Information on openLCA and download software. Available on: http://www.openlca.org/ Last access: April 2019
7. Ortega, E. Manual de investigación comercial (3a edición). Madrid: Pirámide. 1998.

E-3

5S Methodology Implementation in an Industrial Chemical Engineering Laboratory

Nahiara Azanza, Junkal Gutierrez, Josune Amurrio, Arrate Santaolalla, Gorka Gallastegui*

Department of Chemical and Environmental Engineering,
Faculty of Engineering Vitoria-Gasteiz
C/ Nieves Cano 12, 01006 Vitoria-Gasteiz
**gorkajavier.gallastegui@ehu.eus*

Introduction

It is well known that traditional lecture-based instruction presents deficiencies and areas for improvement. As such, the incorporation of enhanced, active-learning methodologies is gaining support from Spanish universities. In active learning, students are placed at the centre of the educational process, with a focus on the learning process itself. Consequently, the key issue is to achieve a synergy between knowledge and skills in order to respond to the emerging demands of a constantly evolving job market.

However, a revolution of the mainstream education system implies several changes, such as novel practicals, tools or technologies and, what is probably more important, commitment, initiative and motivation of the staff. Taken together, all the above should allow the university to achieve greater competitiveness. In order to achieve this level of excellence, safe facilities and appropriate operating methods that safeguard the health and well-being of the people inside the University are essential.

The 5S lean tool is known to improve system performance and is considered to play a significant role in establishing a Total Quality Management (TQM) environment [1, 2]. With implementation of the 5S management method (hereinafter abbreviated as 5S) in university laboratories, such installations become industrial laboratories and commit themselves to adopt the conditions of security and organization usually found in industry. However, unlike industrial laboratories, where productivity tends to prevail, teaching laboratories are devoted to the training of new professionals in different scientific and engineering fields.

In this context, 5S appears to be an effective tool for a successful formative process. Its introduction entails reducing laboratory risks to the lowest level possible, thereby also reducing working hours and costs (it should not be forgotten that most students have no prior experience in technical laboratories), as well as broadening the space available for the location of the resources.

5S, which stands for the five Japanese words Seiri, Seiton, Seiso, Seiketsu, and Shitsuke, has been used in the automotive and other industries and comprises a set of low-cost and technologically undemanding practices that aim to generate productivity improvements by creating and sustaining clean and well-organized workplaces [3].

However, it should be emphasised that 5S is more than simply a cleaning-up or housekeeping activity: it is the foundation block upon which a company can build its lean initiative [1]. In addition, it is a visual management tool and a structured methodology for creating best practice in a clean, organised and efficient working environment. As such, it can assist with the elimination of frustration, stress, space limitation and inventory management. In short, 5S is a good way to manage university science and engineering laboratories.

Objective and Conceptual Framework

The aim was to implement 5S in the three teaching laboratories (Chemical Engineering, Basic Chemistry and Environmental Technology) of the Department of Chemical and Environmental Engineering in the Faculty of Engineering Vitoria-Gasteiz (University of the Basque Country (UPV/EHU)) in order to achieve and maintain order and maximize efficiency.

This study was carried out during the 2018-2019 academic year in the framework of the *Campus Bizia Lab Programme* (CBLP) of the UPV/EHU. This initiative is a follow-up to the "University Educators for Sustainable Development" project included in the European Union Lifelong Learning Programme 2007-2013 for education and training. CBLP was created to address sustainability challenges within the university. Under the umbrella of the Sustainability Directorate and Educational Advisory Service, this programme promotes a close working relationship between the different members of the university: Teaching and Research Staff (TRS), Administration and Services Staff (AAS) and students, with the latter playing a pivotal role as they are the primary users of campus services.

The main actions undertaken as part this project (from February to July) will be brought together in an End-of-Degree project under the supervision of the Quality and Innovation Unit at the UPV/EHU.

Methodology

As mentioned above, this project involves the implementation of 5S lean methodology in three different teaching laboratories. It is important to note that this project overlapped with the practicals carried out during the second semester in these laboratories, which hindered and delayed its execution.

To begin with, the work-team (made up of 2 TRS, 1 AAS and 2 students) took the decision to consider the three laboratories as a single space instead of working with each of them individually. Taking into account that there was no inventory of the material available in each area, and knowing in advance that the same material was dispersed in different places, it was decided to implement the first S (sort) simultaneously in all three laboratories. In contrast, the remaining steps were applied separately in each laboratory, although taking into account that the decisions adopted in each laboratory have repercussions for the rest.

Step 1: *Seiri* – Sort

Seiri involves sorting through the contents of the workplace and removing unnecessary items. This is an action to identify and eliminate all unnecessary items from the workplace. Thus, all cabinets, drawers and the storage areas were emptied. An inventory of the contents was then carried out, classifying them according to the following items: size, material (glass/plastic), quantity and conservation status (used/new). Any unnecessary objects and waste collected were disposed of. Figure 1 shows an image of this first stage of the process.

Figure 1. Images took during sort stage (1st step)

As of April 15 (paper deadline), the *Seiri* step had been completed satisfactorily. Details on the following steps that are expected to be completed in the following few weeks are dealt with in the next sections, and the final results will be presented at the congress.

Step 2: *Seiton* – Set in Order

Seiton establishes the need to keep necessary items in designated locations for easy and timely retrieval. In this case, the work team met to design the criteria for the organization of each laboratory. Based on the aforementioned inventory, families of elements (such as disposable material (filters, pipette tips, vials, buckets, etc.), cleaning material, material related to Science Week (a leading event in the social communication of science and technology in Spain), protective material (glasses, gloves, laboratory coats, oven gloves, etc.) or equipment manuals) were organized and a first attempt was made to assign the most suitable place for their location.

In addition, a general rule was established whereby all units of the same type of material should remain in the same laboratory. For example, all Büchner/vacuum flasks will be stored in the basic chemistry laboratory, since they are mainly used during the practicals carried out therein. Consequently, sporadic users should enter this laboratory to collect the material and return it there after use.

Although all decisions should be made with the aim of promoting an efficient workflow, this stage is the most complex to execute since large volumes of many different elements (more than 450 catalogued tools) were found during the first stage, thereby making the choice of the correct location for each item at the first attempt somewhat complicated.

Step 3: *Seiso* – Shine

Seiso is focused on keeping the workplace neat and clean. Firstly, all the equipment, supplies and work areas have to be thoroughly cleaned. The second task implies regular (preferably on a daily basis) cleaning. Here too, new working rules and habits are compulsory. For example, the working-team responsible for the project has to make it abundantly clear that the work area should be returned to the condition it was in when the day started, including putting away all tools, materials and supplies used that day. There should be no doubt that it is much safer, comfortable and productive to work in a neat and tidy work environment.

Step 4: *Seiketsu* – Standardize

Seiketsu enables and ensures compliance with the new standards established in the first three steps for a well-articulated and consistently organized work. Procedures and schedules will be written and visual management tools, such as colour coding, signals (showing direction or position), labels, posters and photos, will be strategically positioned.

Step 5: *Shitsuke* – Sustain

Shitsuke consolidates and brings together all previous steps. It involves training and discipline to ensure that everyone follows the 5S standards. In this case, the goal is to sustain the previous four steps and intensify efforts to seek an improvement in each of them. In our case, sustainment is probably the most difficult task of 5S taking into account the high number and range of users (each with their own specific needs) working in the laboratories during the year. With the aim of maintaining and improving the lean methodology implemented, new assessment criteria and a timetable for a periodic review of the 5S status will be agreed.

Results and Conclusions

The accomplishment of this project will enhance performance within the three teaching laboratories and will have a positive effect on students, since a friendlier working environment will encourage them to undertake their laboratory practicals in an orderly and efficient manner, therefore improving their academic results.

The lean methodology established herein must withstand the test of time, and this will only be possible if emphasis is placed on the protocols required to accomplish effective knowledge transfer and continuous improvement of the working environment and working conditions.

On a secondary level, it should be noted that if the current study had not been performed, the time wasted in searching for laboratory tools, as well as the additional costs due to the unnecessary purchase of material that was already present in the lab but not located, would increase considerably.

Acknowledgements

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References

1. Chitre, A.R., Implementing 5S methodology for lab management in the quality assurance lab of a flexible packaging converter, University of Wisconsin-Stout, 2010.
2. Ramdass, K. Integrating 5S principles with process improvement: a case study. Portland International Conference on Management of Engineering and Technology, 1908-1917, 2015.
3. Kanamori, S., *et al.*, *Tropical Medicine and Health*, 44 (21), 1-8, 2016.

E-4

Role-Play Based Learning: An Application to the Economics of Climate Change

M. Escapa[1]*, M.L. Campo[1] and A. de Ayala[2]**

[1] Dept. of Fundamentals of Economic Analysis I,
School of Economics and Business Studies, University of the Basque Country (UPV/EHU).
[2] Dept. of Applied Economics I, School of Social and Communication Sciences,
University of the Basque Country (UPV/EHU).
Corresponding author: M. Escapa (marta.escapa@ehu.eus)
***Presenting author: A. de Ayala (amaya.deayala@ehu.eus)*

ABSTRACT

This paper presents a learning experience on the economics of climate change based on role play. The aim is to enhance students' knowledge of climate change and its consequences and their understanding of different countries' mitigation policies and strategies. Two tests have been designed involving questions related to climate change, which are answered by all student groups participating in the learning experience. To evaluate the effect of the role game in achieving the learning objectives, the role play is performed in only some of the student groups before the second test.

Keywords: climate change; role-play game; climate negotiations

1. Introduction

Tackling the climate change caused by increased concentrations of greenhouse gases (GHGs) in the atmosphere is one of the most pressing global challenges of this century. By its nature, climate change is a complex and interdisciplinary subject and requires an education proposal that will help students develop a better understanding of the problem. Scientific evidence exists on the need and effectiveness of using role-play games to improve teaching/learning on climate change. (Sterman *et al.* 2015; Meya and Eisenack 2018).

The proposal presented here seeks to improve students' knowledge of the causes, mechanisms, consequences and possible responses to climate change. To this end, we have designed a learning experience based on role play, "The International Climate Negotiation Game" (Lucas, Escapa and González-Eguino, 2015). This game is designed to simulate summit talks at the United Nations Framework Convention on Climate Change, where countries negotiate reductions in GHG emissions. In the game, each participant plays the role of an institutional representative of one country and experiences first-hand the details of the international climate change negotiation process.

This learning proposal has three aims: (i) To improve students' knowledge of climate change; (ii) To improve their understanding of different countries' mitigation policies and strategies; and (iii) to help students identify the principal reasons for success and failure in international agreements on environmental protection[1].

2. Description of the Learning Activity

The learning activity was prepared in three parts. The first part consisted of a 10-question "pre-test " dealing with the principal scientific and socio-economic aspects of climate change and was performed in all groups. The second part consisted of the role play and was only carried out in some of the groups, in order to analyse and compare the effectiveness of the game on learning about climate change (see section 3.2). The third and last part was a 10-question post-test about causes, mechanisms, consequences and possible responses to climate change (with particular emphasis on climate policy negotiations), which was performed with all groups[2].

We selected 4 student groups of the University of the Basque Country (UPV/EHU) from different levels, totalling more than 100 participants (see Table 1).

[1] The results presented in this work were obtained within the framework of an Educational Innovation Project (PIE-HBT Cod. 36 2018/2019) financed by the Offices of the Vice-Rector for Innovation, Social Outreach and Cultural Action of the University of the Basque Country (UPV/EHU). As well as the authors of the work, other participants in the project included are Alberto Ansuategi and Jose Manuel Chamorro (researchers from the UPV/EHU); Ibon Galarraga and Mikel González-Eguino (researchers from the Basque Centre for Climate Change, BC3) and Josu Lucas (secondary school teacher).

[2] Tests are available upon request.

Table 1. Characteristics of student groups participating in the learning experience

Student Group	Degree (course)	Subject	Students Pre-test	Post-test students	Role play
Vitoria	Business Administration and Management (1st yr. BAM)	Introduction to Microeconomy	46	43	NO
Leioa	Labour Relations and Human Resources (1st yr. LRHR)	Political Economics	27	21	YES
Sarriko	Tax and Government (2nd yr. TG)	Valuation of Business Assets	12	20	NO
Bilbao	"Experience Classrooms"	Microeconomy	24	pend.	pend.
			Total: 109	Total: pend.	

Each of the 4 groups sat the pre-test and post-test; however only 2 of them played the role game before the post-test[3]. For the groups that did play the game, material was designed to explain and introduce the main concepts of climate change economics and this material was presented together with the game. By comparing the results of the post-test between groups that played the game and those that did not, we can see the effects of the game on learning.

3. Results

3.1. Pre-test Results

The average score obtained by each of the groups in the pre-test is quite similar, at around 6 out of 10. As shown in Table 2, there are hardly any deviations in the average results of each single group as compared to the total mean taking the 109 participants as a single group.

Table 2. Average score for pre-test

Group	Vitoria	Leioa	Sarriko	Bilbao	Total
Average score (pre-test)	5.85	5.63	5.92	5.62	5.75

Analysing the results of each group in each of the 10 questions in the pre-test, we see that there are no differences between groups in terms of the questions they most often got right or wrong.

[3] In the case of the fourth student group (Bilbao), the post-test will be conducted in May after they have played the game.

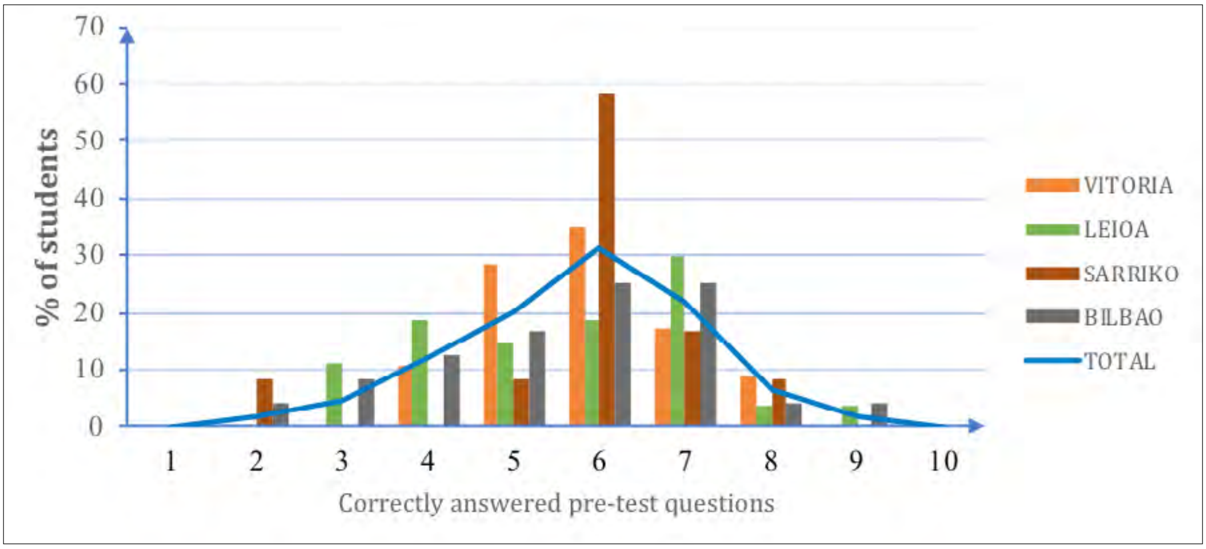
Figure 1 shows the distribution of students by score obtained in the pre-test (0 to 10) for each of the groups (Vitoria, Leioa, Sarriko and Bilbao) and for all groups taken together (blue line).

3.2. Climate Negotiation Game

Due to time restrictions, the role play is a simplified version of the complete game (Lucas, Escapa and González-Eguino, 2015). So far, only the Leioa group has played the game before sitting the post-test. The Bilbao group will also play the game during the month of May.

The simplified game consists of a single round of negotiations in which participants (divided into 10 groups of countries representing all the countries in the world) have to decide whether or not to sign an agreement on climate change. Specifically, by signing the agreement they undertake to reduce their CO_2 emissions, thus contributing to mitigating the negative effects of climate change in the future.

Figure 1. Scores obtained in the pre-test on Climate Change



For the agreement to be successful, it must be signed by at least 7 of the 10 countries. If a country decides to sign up to the agreement, it has to reduce its emissions; this represents a cost for it and a benefit for all countries, given that emission reduction is considered a public good. The benefit and cost is specific to each country and is private information which they can choose whether or not to share with others.

If there is no negotiation, there will be no agreement, since at an individual level the best strategy of several countries is not to sign. However, at a global level, the shared gains if they all sign the agreement are greater than if there is no agreement. It is explained to the players that it is possible to make transfers/payments to other countries so that they do or do not sign the agreement. Countries, therefore, are free to negotiate and commit to payments through bilateral or multilateral agreements.

Once the game has been explained, each group of students receives the instructions and information on the country they are to represent and the negotiation process begins, in which they negotiate freely with other countries to decide on their vote and on any possible transfers of revenue between them. Once the time for negotiating is up, the countries give their vote and the payments for each country are calculated, depending on whether or not the agreement has been reached and whether the country in question has signed up to it or not.

3.3. Post-test results

Table 3 shows the average obtained by each of the groups in the post-test (except for the Bilbao group where it has yet to be carried out). A major difference can be seen in the average score obtained by the Leioa group, which had previously taken part in the role play, as compared to the average scores of the Vitoria and Sarriko groups, which had not. Indeed, in the Vitoria and Sarriko groups the average post-test score was lower than that obtained in the pre-test.

Table 3. Average score for the post-test

Group	Vitoria	Leioa	Sarriko	Bilbao
Average score (post-test)	4.32	7.19	4.85	Pend.

This positive effect of the game on the learning process is also clearly visible in Figure 2. The percentage of students who obtained a score of over 6 in the group where the game was played (Leioa) is higher than the groups where it has not been played (Vitoria and Sarriko). In the Vitoria and Sarriko groups, the percentage of students who scored less than 5 was greater than in the pre-test.

Figure 2. Scores obtained in the post-test on Climate Change

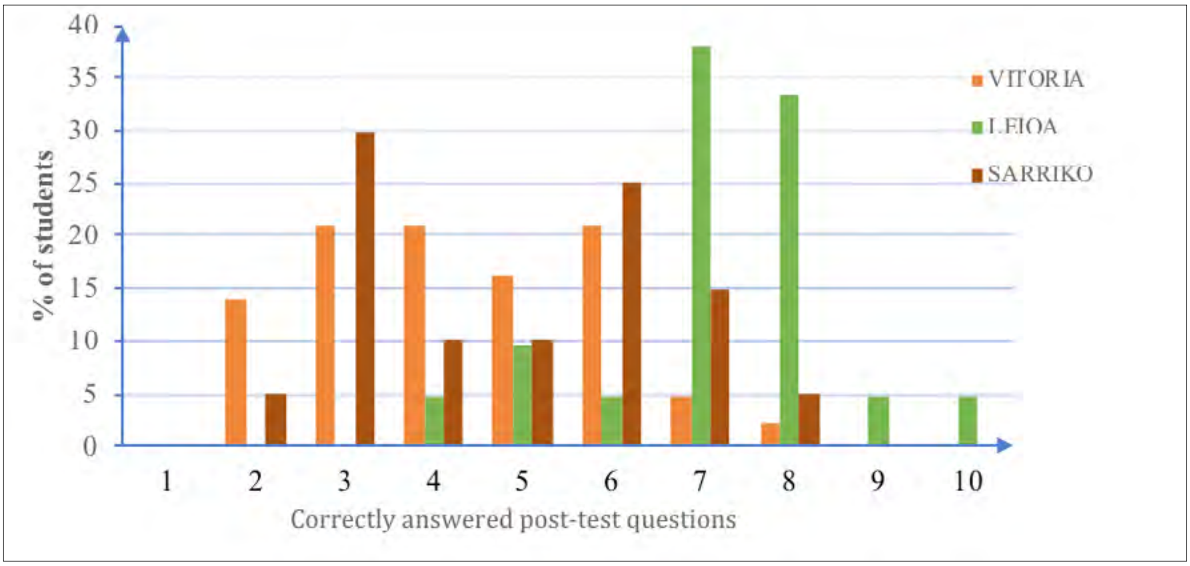
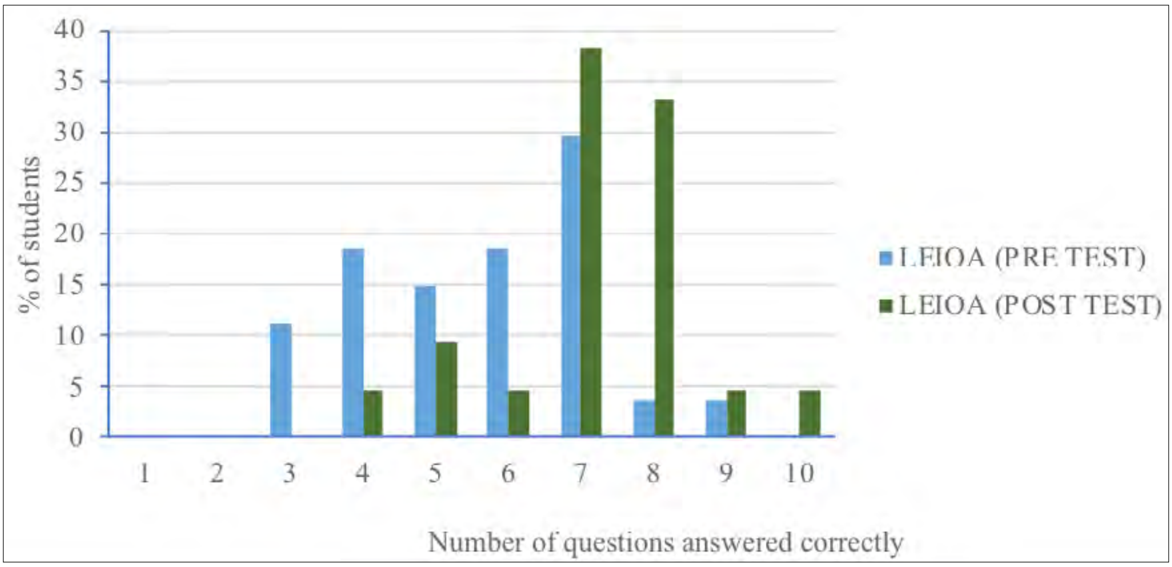


Figure 3 gives a comparison of the results of the pre- and post-test for the Leioa group, which played the climate negotiation game, and shows the improvement in the group's scores. Once we have the results of the post-test for the Bilbao group (which will previously have played the game), we will be able to compare it with the results from the Leioa group and see whether the positive effect of the role play on learning is replicated.

Figure 3. Evaluation of knowledge on climate change before and after the role play



References

Lucas, J., Escapa, M., González-Eguino, M. (2015), El uso de juegos de rol en la docencia: El juego de la Negociación Climática Internacional, Repositorio ADDI, http://hdl.handle.net/10810/15117

Meya, J.N., Eisenack, K. (2018), Effectiveness of gaming for communicating and teaching climate change, Climatic Change, Vol. 149, pp. 319-333.

Sterman, J., Franck, T., Fiddaman, T., Jones, A., McCauley, S., Rice, P., Sawin, E., Siegel, L. and Rooney-Varga, J. (2015), WORLD CLIMATE: A Role-Play Simulation of Climate Negotiations, Simulation & Gaming, Vol. 46, pp.348-382.

E-5

Towards Integration of Environmental Dimension in the Colombian University of the 21st Century. Case Study: Technological University of Pereira - Colombia

Jenny Adriana García Palacio*, Jhoniers Guerrero Erazo

Technological University of Pereira.
*jennygarcia@utp.edu.co

ABSTRACT

This project addresses key elements for building a conceptual model that integrates the environmental dimension in the colombian university. This conceptual model will consider institutions missionary functions, campus, and environment. Next, the results of a participatory exercise related to the updating of the Institutional Educational Project (IEP) are presented, as a first step for the integration of the environmental dimension in the Technological University of Pereira (UTP), Colombia.

Keywords: University, Environmental Dimension, Sustainable University.

Introduction

The integration of the environmental dimension in the current colombian university should be based on the balance of environmental, social and economic relations in a given territory, contribute to the knowledge and balance of the society-nature relationship and involve an interdisciplinary work, which integrates concepts and tools from different areas of knowledge.

The integration of the environmental dimension in the current colombian university should be based on the balance of environmental, social and economic relations in a given territory, contribute to the knowledge and balance of the society-nature relationship and involve an interdisciplinary work, which integrates concepts and tools of different areas of knowledge. In this sense, this research is part of the environmental sciences and focuses on the conceptualization and proposal of an integral model that considers the missionary functions of the institution (teaching-training, research, and extension - projection social), the campus and the relationships with its environment. This model will serve for the evaluation, planning and decision making in the face of the incorporation of the environmental component and seeks the environmental sustainability of the universities.

Research problem

Since 1972, different agendas, declarations, and conferences (national and world) have recognized that education plays a fundamental role in the conservation and conservation of the environment. (UN, 1973). The university has also been identified as a key player in society to promote and achieve sustainable development (SD) (Velazquez *et al.*, 2006; Alonso-Almeida *et al.*, 2015; Lozano *et al.*, 2013; Ragazzi & Ghidini , 2017; Brusca *et al.*, 2018).

The importance of the university in the transition towards a sustainable society is due to its missionary role that involves the training of future leaders and professionals (Cortese, 2003, Shiel & Smith, 2017) and the possibility offered by these institutions to be living laboratories because of its resemblance to "small cities" (Alshuwaikhat & Abubakar, 2008; De Castro & Jabbour, 2013). The university as a teaching and research entity should be the main agent of change that provides answers to the problems and challenges of today's society (Gutiérrez, Calvo, & Benayas del Álamo, 2006).

The Amount of universities committed to the inclusion of the environmental dimension is growing. However, the incorporation of this dimension in universities has been directed predominantly from two approaches, the first approach is related to the development of strategies aimed at activities on the campus, through the application of concepts such as "green campus", "sustainable campus" , "Eco-campus", which are based on technological and operational solutions (Yuan & Zuo, 2013, Dagiliūtė *et al.*, 2018) and the second approach considers the integration of sustainability principles in some strategic and reflexive activities of universities (training, research, extension and social projection) (Stephens & Graham, 2010; Adams *et al.*, 2018). According to Lozano *et al.*, 2013, the non-integration of these approaches implies a traditional vision, which depends on reductionist and mechanistic paradigms, which demonstrates the lag of universities in terms of the contribution they make in the construction of sustainable societies. Kolk & Mauser (2002), suggest that organizations that are incorporating the environmental dimension in their work in order to achieve environmental sustainability, require a dynamic model that describes the changes temporarily. Therefore, the transition from traditional universities to environmentally sustainable universities transcends social, economic, organizational limits and involves multiple agents (Adams *et al.*, 2018).

According to the above and considering that the current approaches to address the environmental sustainability of universities lack a holistic and comprehensive vision, the need to generate a model for the construction or transformation of universities is evident, in which the environmental dimension is integrated and be transverse in its missionary functions as a means to achieve environmental sustainability, according to the foregoing.

Context

The influence of Higher Education Institutions (HEIs) in local economies and in the generation of sociocultural dynamics through the public service they provide through research, extension, and training of future leaders, decision-makers and active citizens. have identified as a fundamental actor for understanding and promoting the concept of environmental sustainability in society (Disterheft *et al*., 2013; Leal Filho *et al*., 2017). A situation that has motivated the signing of numerous agreements, international declarations and guiding frameworks by universities to ratify their commitment to the transition towards sustainable societies. However, these principles have not been implemented due to misconceptions or lack of resources, understanding, and interest in the subject (Leal Filho, 2011).

The integration of the environmental dimension in universities has been considered incorporating the concept of sustainability in the campus through the implementation of strategies based on technological and operational solutions aimed at the efficient use of resources (water, energy, among others) and minimization in the generation of pollutants and waste. However, like cities, universities are considered as unsustainable systems due to the dependence on external matter and energy required for their operation (Holmes & Pincetl, 2012). HEIs like other systems generate entropy as part of their metabolic process, caused by the flows of matter and energy required, it is also important to take into account that despite the implementation of strategies aimed at minimizing consumption and generation of waste indefinite growth is not possible in a world of limited resources (Macedo, 2005).

Some universities have integrated the environmental variable in the curriculum, with the purpose of changing the focus on teaching and learning processes by including the principles, values, and practices related to Sustainable Development (Alonso-Almeida *et al*., 2015).

Therefore, it has been identified that one of the weaknesses for incorporating the environmental dimension in HEIs is part of the way of the practical implementation of it, based on the identification and solution of isolated problems that aim to be connected and subsequently integrated into the force, as if it was a puzzle, which, when being assembled, propitiated dynamics of sustainability (Lipschutz et al, 2017). This fragmentation is a reflection of reductionist thinking and mechanistic interpretation promoted by the Newtonian and Cartesian mental models used in the modern educational model (Nonaka & Takeuchi, 2001, Lovelock, 2007, Lozano *et al*., 2013), where emphasis is placed on promotes individual learning and competition that results in professionals who are not prepared for cooperative work (Cortese, 2003). For De Sousa (2006), the university of the 21st century must make the transition from the model of institution based on decontextualized disciplinary knowledge in its relationship with society, to a reflexive and critical institution, which innovates and bets for interdisciplinarity based on the dialogue between knowledge, through different practices that are synthesized in an "ecology of knowledge" at the service of society.

Hence, the incorporation of the environmental dimension in universities has been a slow process whose actions are directed in most cases to one or few elements of the system without a systemic and holistic vision (Denman, 2005, Ferrer-Balas *et al.* , 2009; Koester *et al*., 2006; Lipschutz et al, 2017). The foregoing prevents them from including the dynamics and diversity of socioecological systems, leaving aside the analysis of their environment. On the other hand, Blanco-portela, *et al.* (2017), argue that the possible barriers that affect the integration of the environmental dimension in HEIs should be identified, in order to anticipate, prevent and overcome these obstacles.

In this sense, the present research aims to develop a model for the integration of the environmental dimension of HEIs, based on a new approach that transcends the current vision of environmental sustainability in the university, which focuses on the evaluation of environmental impact (impact on the quantity and quality of natural resources) caused by the different activities carried out on the campus (Adams *et al*., 2018).

In Colombia, the National Accreditation System includes the environmental variable within the guidelines for Institutional Accreditation; However, the characteristics and indicators to determine their inclusion have not been established. The objectives of accreditation consider environmental development and therefore the inclusion of the environmental dimension in an integral manner must be considered (CNA, 2015). Hence, it is not possible to think about the quality of higher education outside the environmental component.

Advances in the integration of the environmental dimension in the Technological University of Pereira (UTP), Colombia

The UTP with the objective of taking a first step towards the integration of the environmental dimension in its work updated its Institutional Educational Project (PEI). The PEI is the academic navigation letter of the university, according to the National Accreditation Council (CNA, 2015), self-assessment and self-regulation allow the university continuous improvement with a view to achieving excellence and institutional autonomy, for which it must orient its missionary purposes, objectives, plans and projects in a manner consistent with the mission and with the Institutional Educational Project (PEI).

The UTP is a public (state) Colombian university located in the city of Pereira (Colombian coffee axis), within the Metropolitan Area of Central West, has a total university community of 18,870 people, which is divided as follows: 15,616 students in the undergraduate programs and 1,504 in the graduate programs, 395 administrative officers and 1,355 teachers (Statistical Bulletin UTP, 2019).

As part of the process of updating the PEI of the UTP, meetings were held called University Cloisters, which were held with the curricular committees of the undergraduate and graduate programs and with the councils of the faculties, so it can be affirmed that there was a representation of all the institutions of the institution: students, graduates, teachers, and managers; In addition, two additional cloisters were held, one with the coordinators of all administrative processes and the other with the university's management team.

In order to know the perceptions of the university community regarding the topic of interest, in each of the cloisters we worked in groups around some questions. Then, the categorization of the primary information was made and analyzed through mixed triangulation (data from the "contributions" cloisters, official documents of the university "what there is" and theories (Flick, 2014), until the construction of an analysis that allowed establishing the guidelines for a proposal that represents the interests and needs of the university community.

Next, the results of the collective construction of the PEI proposal (Figure 1) and the outline with the proposal of integral professional training are presented, considering that this training does not constitute chairs, nor specific curricular contents, but is part of the academic life of all the programs and institutional activities, and implies educational practices for the formation of critical thinking, education for citizenship and democracy, and commitment to environmental sustainability (Figure 2).

Figure 1. Outline of the Institutional Educational Project of the Technological University of Pereira

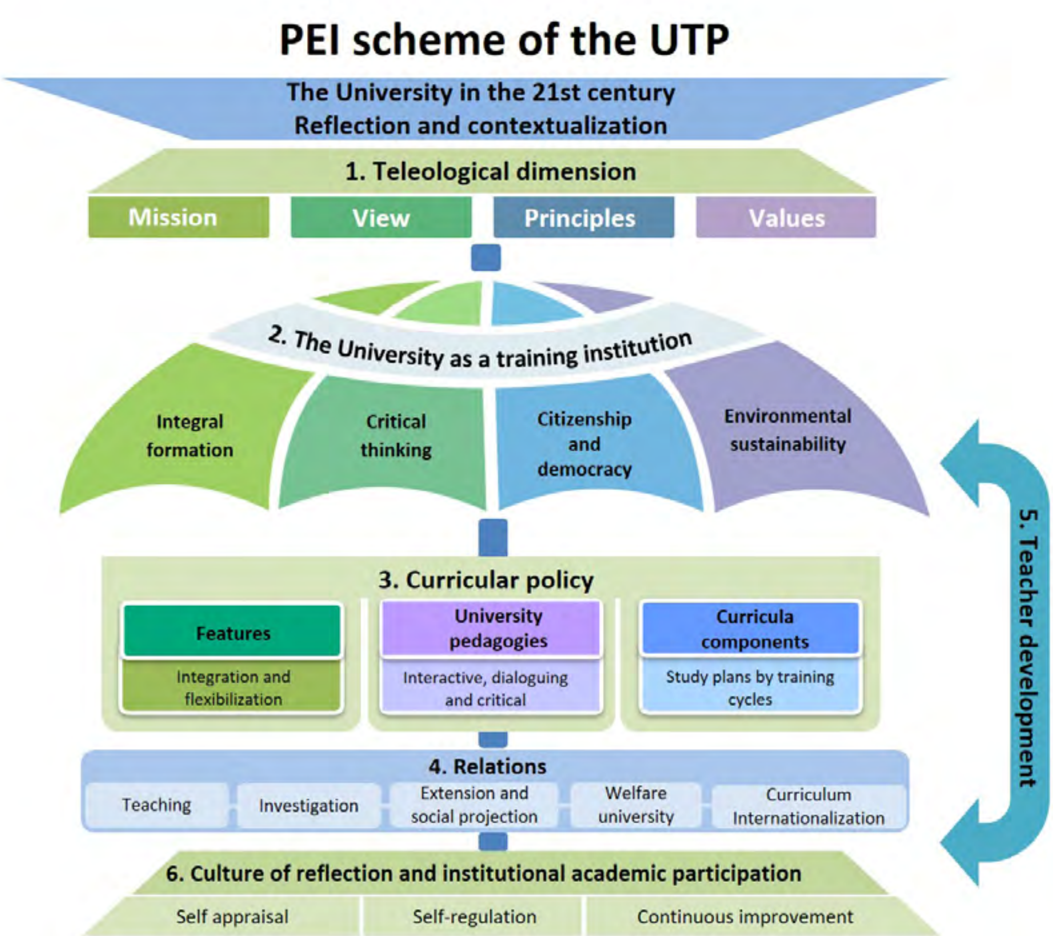
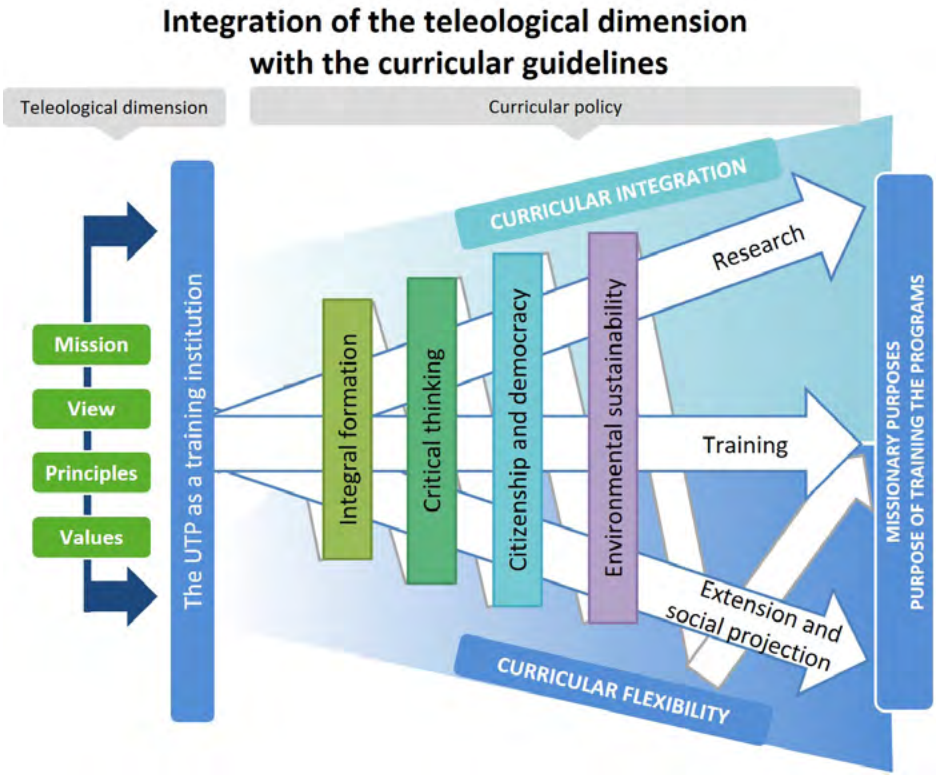


Figure 2. Comprehensive professional training at the University



Conclusions

- In the construction of a new university institutionality, participatory evaluation is crucial, in which all members and groups participate, seeking to generate consolidated self-reflection and self-regulation processes, open an external evaluation in pursuit of the autonomy of academic and institutional processes.
- The university must be linked to networks and local and global academic communities through research processes that create, transform, transfer, contextualize, apply, manage, innovate, and exchange knowledge, to contribute to the sustainable development of society.
- The university must be a community committed to the integral formation of citizens with critical thinking and the ability to participate in the strengthening of democracy, with an interdisciplinary perspective for the understanding and search for solutions to today's and future's problems, based on the knowledge of sciences, disciplines, and knowledge.
- The development of this work generated important information to understand the relationship university - environment, which is essential for the conceptualization of universities that integrate the environmental dimension to achieve environmental sustainability.

References

Adams, R., Martin, S., & Boom, K. (2018). University culture and sustainability: Designing and implementing an enabling framework. *Journal of Cleaner Production*, *171*, 434–445. https://doi.org/10.1016/j.jclepro.2017.10.032

Alonso-Almeida, M. D. M., Marimon, F., Casani, F., & Rodriguez-Pomeda, J. (2015). Diffusion of sustainability reporting in universities: Current situation and future perspectives. *Journal of Cleaner Production*, *106*, 144–154. https://doi.org/10.1016/j.jclepro.2014.02.008

Alshuwaikhat, H. M., & Abubakar, I. (2008). An integrated approach to achieving campus sustainability: assessment of the current campus environmental management practices. *Journal of Cleaner Production*, *16*(16), 1777–1785.

Brusca, I., Labrador, M., & Larran, M. (2018). The challenge of sustainability and integrated reporting at universities: A case study. *Journal of Cleaner Production*, *188*, 347–354. https://doi.org/10.1016/j.jclepro.2018.03.292

Cortese, A. D. (2003). The Critical Role of Higher Education in Creating a Sustainable Future. *Planning for Higher Education*, *31*, 15–22.

Dagiliūtė, R., Liobikienė, G., & Minelgaitė, A. (2018). Sustainability at universities: Students' perceptions from Green and Non-Green universities. *Journal of Cleaner Production*, *181*, 473–482. https://doi.org/10.1016/j.jclepro.2018.01.213

De Castro, R., & Jabbour, C. J. C. (2013). Evaluating sustainability of an Indian university. *Journal of Cleaner Production*, *61*, 54–58.

Disterheft, A., Caeiro, S., Azeiteiro, U. M., & Filho, W. L. (2013). *Sustainability Science and Education for Sustainable Development in Universities: A Way for Transition. Sustainability Assessment Tools in Higher Education Institutions*. (S. Caeiro, W. L. Filho, C. Jabbour, & U. M. Azeiteiro, Eds.). Springer International Publishing Switzerland. https://doi.org/10.1007/978-3-319-02375-5

Gutiérrez, J., Calvo, S., & Benayas del Álamo, J. (2006). Educación para el desarrollo sostenible: evaluación de retos y oportunidades del decenio 2005-2014. *Revista Iberoamericana de Educación*, *40*(40), 25–69. Retrieved from http://dialnet.unirioja.es/servlet/articulo?codigo=2162363&info=resumen&idioma=SPA

Kolk, A., & Mauser, A. (2002). The evolution of environmental management: From stage models to performance evaluation. *Business Strategy and the Environment*, *11*(1), 14–31. https://doi.org/10.1002/bse.316

Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: Becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, *48*, 10–19. https://doi.org/10.1016/j.jclepro.2011.10.006

Lozano, R., Lukman, R., Lozano, F. J., Huisingh, D., & Lambrechts, W. (2013). Declarations for sustainability in higher education: Becoming better leaders, through addressing the university system. *Journal of Cleaner Production*, *48*, 10–19. https://doi.org/10.1016/j.jclepro.2011.10.006

ONU. (1973). Informe sobre el Medio Humano. Conferencia de Las Naciones Unidas Sobre El Medio Humano, 89. Retrieved from http://www.dipublico.org/conferencias/mediohumano/A-CONF.48-14-REV.1.pdf.

Ragazzi, M., & Ghidini, F. (2017). Environmental sustainability of universities: Critical analysis of a green ranking. *Energy Procedia*, *119*, 111–120. https://doi.org/10.1016/j.egypro.2017.07.054

Shiel, C., & Smith, N. (2017). Sustainable Development Research at Universities in the United Kingdom, 13–26. https://doi.org/10.1007/978-3-319-47883-8

Stephens, J. C., & Graham, A. C. (2010). Toward an empirical research agenda for sustainability in higher education: exploring the transition management framework. *Journal of Cleaner Production*, *18*(7), 611–618.

Velazquez, L., Munguia, N., Platt, A., & Taddei, J. (2006). Sustainable university: what can be the matter? *Journal of Cleaner Production*, *14*(9–11), 810–819. https://doi.org/10.1016/j.jclepro.2005.12.008

Yuan, X., & Zuo, J. (2013). A critical assessment of the Higher Education for Sustainable Development from students' perspectives - A Chinese study. *Journal of Cleaner Production*, *48*, 108–115. https://doi.org/10.1016/j.jclepro.2012.10.041.

E-6

Definition of the Key Objectives of Sustainable Development in Civil Engineering: An Experience in the Classroom

Cristina Peña-Rodriguez*, Florencio Fernández-Marzo

Department of Chemical and Environmental Engineering, Faculty of Engineering, Gipuzkoa.
University of the Basque Country (UPV/EHU)
Pza. Europa 1, 20018 Donostia-San Sebastián (Spain)
**cristina.pr@ehu.eus*

Introduction

The environmental, social and economic global situation lead us a new world that differs from the one of some decades ago. It is necessary to include these changes in the engineering degrees so that the graduates have the necessary skills to look for solutions in the new scenarios. In 2015, countries adopted the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDG) with 168 targets and indicators. As United Nations said, the Sustainable Development Goals are a call for action by all countries to promote prosperity while protecting the planet. There are necessary new strategies that build economic growth and address a range of social needs including education, among others, while tackling climate change and environmental protection. For that reason, Universities are working for adapt the curriculum of different engineering degrees to this new situation. Both the methodology and the technical contents must be adapted.

The target 4.7 is specifically related to Education for Sustainable Development (ESD): "By 2030, ensure that all learners acquire the knowledge and skills needed to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and appreciation of cultural diversity and of culture's contribution to sustainable development" [1]. The most important difficulty of this evolution in the universities is related with the fact that degrees tends toward specialization, reducing the points of view of the graduates to solve problems [2, 3]. Although the holistic modification of curricula could be the most suitable change, they can be several limitations related with the training of the faculty. Then, the transition from the actual situation to an overall formation in this area requires the development of activities that could include technical, social and economic aspects of sustainability. The final objective must be that the future graduates will think in terms of sustainable development.

This work describes one activity performed with students of Civil Engineering in the Environmental Engineering course. This activity can be used to any other degree. The main objectives are the analysis of the Sustainable Development goals and associated targets, and the identification of ones directly related with their professional activities. For that, employed methodology has been puzzle. The students works in the classroom in work teams in order to research the relation between the targets and Civil Engineering. After that, each team presents their conclusions for each goals. The students must discuss the conclusions obtained by each group, and finally they have created a document defined as a manual of Sustainable Practices in Civil Engineering.

Methodology

The Engineering Faculty of Gipuzkoa (University of the Basque Country) offers, among others, Civil Engineering Degree. Its curriculum include in the 3rd year the Environmental Engineering course. The main competence is related with the environmental assessment of projects, plans and programs. For that, along the course, students develop abilities related with several environmental factors as water, atmosphere and residues, among others. For that, project based learning methodology is employed during the 15 weeks of the course. It includes different activities as flipped room or puzzle. This methodology facilitates the development of the proposed activity because the students are accustomed to working in groups and with active learning methodologies. The sustainability concept is presented along the first week of the course, together with the analysis and discussion about some articles related with the relation and relevance of environmental engineering for Civil Engineering profession.

One session of that course of two hours of duration was used for this activity. The description of the activity is presented in Table 1. Students were distributed in works team with six person each of one. The activity starts with an explanation about SDG and the distribution in 17 goals with 168 targets with the corresponding indicators. Then, the professor explains the activity objectives and stages (10 min). The students has been distributed into groups of 6 identified as A, B and C. Within each group, three SDG groups (1-6, 7-12, 13-17) have been made identified as 1, 2 and 3, respectively. In pairs, the students have been analysing during 30 min the corresponding SDG (A1, A2, A3, B1, B2, B3, C1, C2, C3) and identifying those directly related to civil engineer work. For this, each goal related to the degree of Civil Engineering has been assigned actions that could develop in their professional future. When all the groups have finished, expert meetings have been held in which the students who have analysed the same SDG have met during 30 min (A1, B1, C1, A2, B2, C2, A3, B3, C3). In these meetings, they have discussed about their decisions and the allocations made to each goal of each SDG. Finally, the students have met with their original group (A, B, C) and have presented the conclusions of each SDG group analysed (40 min), with which they have generated the document product of the activity: Development of the activity of Civil Engineer according to the SDG.

Table 1. Stages and description of the activity

Stage of the activity	Time (min)	Work teams			Stage objective
		A	B	C	
1	5	A1 A2 A3	B1 B2 B3	C1 C2 C3	Teams formation and distribution of SDG to each sub-group
2	30	A1	B1	C1	Personal analysis of 1-6 SDG looking their relation with Civil Engineering profession
		A2	B2	C2	Personal analysis of 7-12 SDG looking their relation with Civil Engineering profession
		A3	B3	C3	Personal analysis of 13-17 SDG looking their relation with Civil Engineering profession
3	30	A1	B1	C1	Discussion about 1-6 SDG for define the most relevant for Civil Engineering profession
		A2	B2	C2	Discussion about 7-12 SDG for define the most relevant for Civil Engineering profession
		A3	B3	C3	Discussion about 13-17 SDG for define the most relevant for Civil Engineering profession
4	40	A1 A2 A3	B1 B2 B3	C1 C2 C3	Discussion in original teams for define the items of the document Development of the activity of Civil Engineer according to the SDG.

Results and discussion

The SDG has been analysed by the students by reading and discussing the most suitable answer for each target of the corresponding Goal. The activity is performed by both personal and work in teams. Obtained product, the document with the selected targets, has been researched in order to determinate the most relevant objectives according to the students. For that, the relevance of a target in the Civil Engineering profession has been calculated as the percentage of selected target by the students and the quantity of the targets in a Goal. Results shown, in the student opinions, that SDG number 6 is the most important, 7 and 11 are very relevant, and 3, 13 and 14 have some relation with Civil Engineering.

This result has been compared with the one published by The World Federation of Engineering Organizations (WFEO) [3] and its network of national and international organizations in more than 90 countries representing 20 million engineers across all disciplines. In fact, this document can be defined as an activities map of the association. The report reflects that the most relevant SDG are 6, 9, 11, 13, 16 and 17. It takes also special importance the number 4 related with quality education. The evaluation of the selected Goals indicates that the most relevant objective of the organization related with performed activity in the classroom can be resumed as apply engineering and technology for promoting sustainable development, climate change adaptation, disaster risk mitigation, public health and poverty alleviation. The selected SDG related directly with the Civil Engineering profession, and discarding others related with the policy and management can be listed as 6 (clean water and sanitation), 11 (sustainable cities and communities) and 13 (climate action). Then, students has identify similar objectives from SDG analysis than WFEO. Differences between results can be due to the difficulty of the students to find the possibilities that they have to develop in this area.

In addition, some of the proposals about selected target are very close to the ones form the report of WFEO. For example, students proposals related with water management (Table 2) are related with the design and construction of new wastewater treatment plant and the efficient use of water.

Table 2. Student selection and contributions to SDG 6

Goal 6. Ensure availability and sustainable management of water and sanitation for all		
Targets	Indicators	Student Contributions
6.1. By 2030, achieve universal and equitable access to safe and affordable drinking water for all	6.1.1. Proportion of population using safely managed drinking water services	Design supply networks in all inhabited areas.
6.2 By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	6.2.1 Proportion of population using safely managed sanitation services, including a hand-washing facility with soap and water	Design sanitation networks in the most populated areas
6.3. By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	6.3.1 Proportion of wastewater safely treated	Implementation of wastewater treatment plant
	6.3.2 Proportion of bodies of water with good ambient	Implementation of drinking water treatment plant
6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	6.4.1 Change in water-use efficiency over time	Implement regulations that regulate the efficient use of water in places with shortages.
	6.4.2. Level of water stress: freshwater withdrawal as a proportion of available freshwater resources	
6.6. By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes	6.6.1. Change in the extent of water-related ecosystems over time	Regulate and restrict the massive exploitation of water from natural places
6.a. By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies	6.a.1. Amount of water- and sanitation-related official development assistance that is part of a government-coordinated spending plan	Increase investments in the drinking water and sanitation sections.

References

1. United Nations, 2017. Sustainable Development Goal 4. https://sustainabledevelopment.un.org/sdg4 (accessed 05/10/2019).
2. Cortese, A.D. Planning for a Higher Education Journal, 31, 15–22, 2003.
3. Lozano, R. Journal of Cleaner Production 18, 637–644, 2010.
4. World Federation of Engineering Organizations, 2018. A Plan to advance the achievement of the UN Sustainable Development Goals through engineering https://www.wfeo.org/ (accessed 05/10/2019).

E-7

Facts at your fingertips – for teaching based on UN Sustainable Development Goals

Sara Onrubia*

Granta Design, 62 Clifton Road, Cambridge CB1 7EG, United Kingdom
**sara.onrubia@grantadesign.com*
(Corresponding Author Email: education.team@grantadesign.com)

When the United Nations set out 17 Sustainable Development Goals back in 2015, not only did it spark a global drive towards tackling some of the world's biggest problems, it also provided a new framework from which to teach the next generation of engineers. CES EduPack has long been at the forefront of Environmental and Sustainable Development Engineering Education. The 2019 version of CES EduPack continues to strengthen the data and tools available for this teaching.

Updated data on critical materials and fuel costs allows students to make informed decisions based on reliable information. A holistic view of design finds support through enhanced social and regulatory data and the Eco Audit Tool, which is now available in all Editions of the CES EduPack.

"CES EduPack 2019 supports educators that are using the UN Sustainable Development Goals as a starting point for project work around social equality, justice, and technological developments," said Mike Ashby, professor and co-founder of Granta. "Through regular updates to sustainable development data and the addition of new topics such as additive manufacturing and biocomposites to link materials use to real-world production and manufacturing, CES EduPack 2019 empowers students to make stronger design decisions."

New entries in Nations of the World data table

• Child labor • Forced labor and slavery • Minimum wage • Hours worked per week • Fatal accidents at work • Social protection expenditure • Political freedom • Corruption perception index	• Recycling rate • Voice and accountability • Unemployment rate • Research and Development spend • Regulatory quality • IP protection • Global Peace Index

Benefits

• Teaching good decision-making based on good data • Understanding trade-offs • Assessing environmental impacts of products • over their life cycles • Helping students work with uncertain data	• Teaching students to understand stakeholders • Making sure facts are found before judgements are made • Balancing natural, social and manufactured capital • Tying in the social impact of technological advances

E-8

Responsible and Sustainable Purchase of Chemical Reagents at the University: A Further Step Towards a Circular Economy

Amaia González, Naiara Rojo*, Dolores Encinas, Zuriñe Gómez de Balugera

Faculty of Engineering Vitoria-Gasteiz.
Nieves Cano, 18. 01006 Vitoria-Gasteiz, Spain
*naiara.rojo@ehu.eus

Introduction

On September 2015 the General Assembly of the United Nations unanimously approved the 2030 Agenda for Sustainable Development. This Agenda is a global plan of action for people, planet and prosperity that seeks to eradicate poverty, take urgent action on climate change and combat inequalities within and among countries [1]. In order to achieve this global challenge, 17 Sustainable Development Goals (SDGs) that reflect the scope and ambition of this plan were approved.

Universities occupy a unique position within society, as they are both responsible for the creation and dissemination of knowledge, and are drivers of innovation, economic development and societal wellbeing [2]. Therefore, they have a critical role in contributing to the SDGs.

A number of SDGs and their targets explicitly recognize education and research [1], for example:

- SDG 4: ensure inclusive and equitable quality education and promote lifelong learning opportunities for all.
- SDG 9: build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation.

However, the contribution of the universities could be much broader and a great number of actions could be carried out in order to provide students, academic staff and administration and services personnel with the skills and motivation to address SDGs.

In recent years the university sector has begun to engage with the ambitious challenge of transforming the world. However, there is an urgent need for the sector to accelerate its actions [2]. Within this framework, the University of the Basque Country (UPV/EHU) has assumed the challenge to contribute constructively and critically to this plan on a local scale by taking on commitments such as:

- The transversal incorporation of the SDGs to the policies and activity of the university.
- The intensification of the development of competences for sustainability among students, teachers and administration and services personnel.
- The promotion of innovative projects that address the challenges of the 2030 Agenda.

The goal of this project was to implement a protocol that enabled a more responsible and sustainable purchase and management of the chemical reagents used in various Faculties and Departments of the UPV/EHU. The application of this protocol plays a key role in the transition towards the Circular Economy of the university (SDG number 12: responsible consumption and production: Guarantee sustainable models of production and consumption).

This work was developed within the framework of the Campus Bizia Lab (CBL) challenge, an initiative that derives from the Erasmus University Educators for Sustainable Development Project in which the UPV/EHU participated in the 2013-2016 period. It aims to trigger a collaborative process between academic staff, administration and services personnel and students (transdisciplinary approach) in order to respond to sustainability challenges within the University itself.

Methodology

In order to attain the main objective twelve different experimental subjects taught by three Departments at the Alava Campus and one at the Bizkaia Campus of the UPV/EHU were selected for this study. The Departments involved in the study are listed in Table 1.

Table 1. Departments involved in the study

Alava Campus
Faculty of Engineering Vitoria-Gasteiz
Department of Chemical and Environmental Engineering
Faculty of Pharmacy
Department of Analytical Chemistry
Department of Inorganic Chemistry
Bizkaia Campus
Faculty of Engineering in Bilbao
Mining and Metallurgical Engineering and Materials Science

The project was divided into four consecutive tasks that were carried out by 15 members of the teaching staff, 3 members of the administration and services personnel and 2 students.

TASK 1. INVENTORY OF CHEMICAL REAGENTS. Information regarding the chemical reagents used in the laboratory practices of the selected subjects was gathered (name of the reagent, CAS number, quantity used in each experiment, etc.) and collected in an inventory.

TASK 2. IDENTIFICATION OF COMMON NEEDS. The chemical reagents used in all the Departments involved in the project (common reagents) were identified.

TASK 3. COST-BENEFIT ANALYSIS. A comprehensive cost-benefit analysis of the joint purchase and management of the chemical reagents was carried out. This analysis took into account both economic and environmental issues.

TASK 4. JOINT PURCHASE PROCEDURE. A joint purchase procedure that enabled a more responsible and sustainable use of the chemical reagents use in more than one Department was designed and implemented.

Results

The identification of the common reagents used in the twelve selected subjects and the results achieved in the cost-benefit analysis of their joint purchase and management led to the definition of a "protocol for the joint management of reagents". This procedure ensures the joint purchase, storage and use of the reagents that are used in two or more Departments, in addition to an accurate and updated inventory of the chemicals stored.

Several economic and environmental benefits resulted from this innovative management strategy, such as:

- better control and management of the chemical reagents used in the laboratories.
- waste prevention due to lower generation of chemical residues.
- reduction in the costs associated with the purchasing of reagents and the collection and handling of chemical waste.

The main difficulty that had to be overcome was the current chemicals purchasing policy within the UPV/EHU, which stipulated that ordering was carried out at departmental level using the departmental budget. In addition, the lack of a central stockroom facility hampered the management of common chemical reagents, and a laboratory-to-laboratory exchange strategy was set up as the most viable alternative.

Conclusions

The design and implementation of a protocol for the joint management of the reagents used in several Departments of the UPV/EHU had a positive economic and environmental impact. The protocol can be extended to other Departments, Faculties and services of the UPV/EHU, and constitutes an important basis on which a global joint purchasing strategy can be designed. This strategy would boost the circular economy and contribute to new sustainability challenges within the University itself.

Acknowledgements

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References

[1] UN General Assembly, *Transforming our world: the 2030 Agenda for Sustainable Development*, 21 October 2015, A/RES/70/1, available at: https://www.refworld.org/docid/57b6e3e44.html [accessed 11 April 2019]

[2] SDSN Australia/Pacific, *Getting started with the SDGs in universities: A guide for universities, higher education institutions, and the academic sector*. Sustainable Development Solutions Network – Australia/Pacific, Melbourne. Available at: http://ap-unsdsn.org/wp-content/uploads/University-SDG-Guide_web.pdf [accessed 11 April 2019]

E-9

Final Year Projects in the Renewable Energies Engineering Field. Practical Cases Specifically Designed for the University Buildings

María González Alriols[1]*, Alain Ulazia[2], Aitor Urresti[3],
Álvaro Campos[3], M. Mirari Antxustegi[4]

[1] Chemical and Environmental Engineering Department, University of the Basque Country.
Escuela de Ingeniería de Gipuzkoa. Plaza Europa 1, 20018, San Sebastián, Spain.
[2] Nuclear Engineering and Fluid Mechanics Department, University of the Basque Country.
Escuela de Ingeniería de Gipuzkoa. Avda Otaola 29, 20500, Eibar, Spain.
[3] Machines and Thermal Engines Department, University of the Basque Country.
Escuela de Ingeniería de Gipuzkoa. Avda Otaola 29, 20500, Eibar, Spain.
[4] Chemical and Environmental Engineering Department, University of the Basque Country.
Escuela de Ingeniería de Gipuzkoa. Avda Otaola 29, 20500, Eibar, Spain.
**maria.gonzalez@ehu.eus*

Introduction

In the fourth year, the students of Renewable Energies Engineering at the University of the Basque Country (UPV/EHU), undertake a 12 ECTS individual project. Supervised by a tutor of the selected research field, the student is free to select a topic that matches her or his personal interests to increase the acquired knowledge in a particular area of the renewable energies engineering discipline. The work done in the project presented as the Final Year Project (FYP) report, is the perfect presentation card to be shown to prospective employers, or as the beginning of the postgraduate studies line. The FYP works as the link between the academic formation and the professional activity and, thus, it should reach enough complexity to emulate an actual engineering problem in the real life. There are several active teaching methodologies, as the Problem Based Learning (PrBL) and Project Based Learning (PjBL) in which the students work with open scenarios and multiple choices solutions. Nevertheless, it is often difficult to have access to actual data (budgets, previsions…) of ongoing projects of engineering enterprises to define the scenario for the students to work in. Even more, it is very instructive to have access to the industrial installations related to the project and it is not easy for university undergraduates to obtain permission to visit them. This the why most of the times the challenges offered to the students are generic, based on estimations and do not correspond to actual engineering projects.

In this work we present the results of several FYP, in the field of renewable energies engineering, that were defined and developed in the very university buildings. The idea started after a call for projects related to sustainability within the university. At this point, and after taking a look to the current situation of different buildings of the university of the Basque Country (UPV/EHU) in terms of energetic efficiency and energy consumptions, the opportunity was clear. Thus, it was proposed to different students to develop FYP that worked in the introduction of renewable energies in buildings of the campus. The proposal was successful as it offered considerable advantages for the students such as proximity, access to data related to consumptions, installations, operational parameters, etc. Furthermore, some of the buildings in which the Renewable Energies Engineering bachelor degree is imparted were energetically very inefficient and used very old based burners fed with gasoil to provide heat and sanitary water. It was considered somehow incoherent and was stimulating for the students to work to provide an improvement in the sustainability of the university installations. Depending on the different interests, some students decided to choose a project devoted to biomass as a way to provide energy, based on the available and abundant forestry resources in the surroundings. Other students were more attracted by the wind energy installations, in particular, mini-wind technology, suitable to be installed in roofs of buildings in cities.

Results and Discussion

The mentioned FYP were successfully completed and each one of them provided an actual engineering proposal for the implementation of renewable energies in the University building. The works included aspects such as the economic estimation, technological requirements and results in terms of energetic efficiency and sustainability. For the projects' development, it was compulsory to create partnerships between students, faculty, and staff, resulting in enriching multidisciplinary experiences in collaboration with different departments. Even if, in some of the studied buildings, the initial idea of implementing a specific renewable energy was not applicable due to the existing configuration of the building and the location of the burner room and accesses, an alternative solution was provided and the study was useful as well. Other aspect that was remarkable was the opportunity for the students of getting in contact with local suppliers and small enterprises of the renewable energy field in the surroundings. In the case of biomass energy, it was necessary to analyse the options of forestry resources supplying, such as pellets or splinters, and the associated transport and storing considerations. In the case of wind energy, the students designed a prototype that was built with existing commercial pieces and was optimized in situ in the roof of the building for which has been designed.

Conclusion

Academic benefits were observed in terms of an opportunity for the supervisors to provide students with authentic hands-on learning experiences of the very close surroundings. Students were able to develop professional skills, gain first-hand work experience and work for the local community contributing to the local real change. In summary, the opportunity was found as enriching for everyone, providing opportunities for applied learning in sustainability.

E-10

Environmental sustainability in Electrical Engineering degree through the inclusion of the Sustainable Development Goal number 15

Zaloa Aginako Arri*, María Begoña Peña Lang

Engineering School of Bilbao, University of the Basque Country
*zaloa.aginako@ehu.eus

Introduction

The next generations of engineers will contribute to solving the serious problems caused by environmental degradation and climate change, in order to cope with these challenges, they must acquire the sustainable development competencies set by UNESCO (UNESCO, 2017). The sustainable development competences should be taken into account in university curricula, they must be inserted in engineering curriculums through the education for sustainable development (ESD). But this is not something new, by 2005 the CRUE (Spanish universities' rectors conference) in the Guidelines for the Inclusion of Sustainability in the Curriculum recommended the inclusion of sustainability competences in university:

> Universities must prepare professionals who are not only capable of using their knowledge in a scientific context, but also to meet social and environmental needs. The entire educational process must be approached holistically to implement sustainability skills across the board so that students can learn to make decisions and take actions based on sustainable criteria. (CRUE, 2005)

According to this recommendation it is necessary to train electrical engineering students to acquire skills to solve problems in contexts of increasing complexity that also include environmental criteria. In the area of electrical engineering, the inclusion of energy saving and efficiency criteria, as well as the environmental impact of facilities for electric power transport, generation and distribution, have been considered for years as design criteria in the construction, renovation or maintenance of all type of facilities. However, in the degree of electrical engineering prevails the use of technical and economic criteria on the environmental criteria when designing electrical installations, being the inclusion of design criteria that consider environmental aspects and energy efficiency very timid.

This paper describes an activity carried out in a subject of the electrical engineering degree to include the sustainable development goal No. 15 *Life on land* in the curriculum. The Goal N. 15 is about: *Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss*. The activity is not just about tackling the problem from a normative point of view, it tries to contextualize the existing regulations and the actions of the electricity distribution companies within the framework of the SDGs and to give a systemic and critical vision to the actions to protect the birdlife that are being carried out currently in our nearest environment (Basque autonomous community).Following the recommendations of UNESCO (2017), an active methodology has been chosen, project-based learning. Thus, with the aim of developing sustainability competences and the competences of the degree, students work actively in teams in order to solve a specific challenge in a self-directed learning context.

Description of the activity

Basically, in the activity students carry out a project to adapt overhead distribution power lines to the regulations to protect the birdlife, the regulations date from 2008 (BOE, 2008). For distribution lines, the regions themselves have the power to regulate the activities within its territory and especially in sensitive environments (protected natural areas), regional governments have a regulatory role and develop specific regulations (Saenz de Buruaga, *et al.*, 2018). The other agent involved is the electric distribution company, that owning the lines has the responsibility for carrying out the modification of lines according to regulations. When developing their technical solutions students must consider the technical and environmental requirements of these three agents, this way the solution will be viable in a real context.

The SDG No. 15, especially in its *biodiversity protection* section, is the guiding thread of the activity that guides the learning of the contents related to sustainable development in the activity, and it also gives a global vision of the intervention on the protection of birdlife beyond the regulatory point of view, transforming the profile of the designer towards a sustainable designer.Another key point of the proposal is its linkage to the student's closest reality. To bring the problem closer to students a news published in the press at the beginning of 2019[1] is used. According to this news an electric distribution company signed an agreement with the Basque government to modify the overhead high voltage lines in the natural protected areas of the region in order to protect the birdlife.

The students work with a real line that exists and that must be modified according to the plan developed by the Basque government which is inside the agreement of the gov-

[1] https://www.eitb.eus/es/noticias/sociedad/videos/detalle/6110667/video-nuevas-torres-alta-tension-evitar-aves-se-electrocuten/

ernment and the distribution company too. It is the feeder No 9 of Fadura substation in the protected area of Bolue located between the municipalities of Getxo and Berango (Biscay).

Figure 1. The news about the modification of electric power lines in the Basque Autonomous Community

Table 1 shows schematically the development of the activity. For the design of the activity Granados model (2019) has been used.

Table 1. Elements of the activity including sustainability and the SDG number 15

Birdlife Protection in distribution overhead lines in Biscay			Sustainability Aspects
Context (syllabus)	Grade	Electrical Engineering	Relationship with SDG: 15 *Life on land* (protection of biodiversity)
	Subject	Electric lines and Electrical Power systems	
	Contents	• Legislation to protect birdlife against hazards in electrical overhead lines. • Distribution lines' elements including those to protects birdlife. • Sustainable development Goals (SDG), what they are. • The 15 SDG • Electrical Distribution Companies and the 15 SDGs (birdlife protection, controlled loggings…)	Concepts and principles of sustainable development: SDG; sustainable development; birdlife hazards with electrical distribution lines.

Birdlife Protection in distribution overhead lines in Biscay			Sustainability Aspects
	Grade's Competences	• Be able to analyse and critically discuss (environmental) problems inherent to electric power transmission lines and electric power systems. • Ability to design creatively, adopting the right decisions, and calculation accurately electric power transport lines. • To apply current legislation to design distribution power lines. • Work in teams	Systemic thinking Critical thinking competence. Collaboration competence
Learning goals	Learning outcomes Learning outcomes	• To know the current legislation on the protection of birdlife and the areas of the Basque Country where it should be applied. • To identify and know technical characteristics of the components of distribution overhead lines. • To apply viable technical solutions in the distribution lines towers for the protection of birdlife, using the suitable elements to protect birdlife. • To design distribution overhead lines considering environmental aspects. • Learn from other team members and collaborate with the team to get to do a viable project, overcoming conflicts and different points of view.	• Know and understand the relationship between the agents involved in the protection of birdlife (legislations, companies and SDG 15), and raise viable solutions with all conditions. • Know and critically analyse the positions of the electrical companies regarding the SDGs and propose your own personal positioning as line designer.
	Assessment	Project document assessment rubric including environmental contents. The environmental contents are about the systemic competence, legislation, and the quality of technical solutions.	• Sustainability questionnaire (at the beginning and at the end). To assess contents about sustainability and SDG. • Work-team Rubric. • Rubric to assess the critical thinking competence about the electrical companies role and the designer role on SDG.

Birdlife Protection in distribution overhead lines in Biscay			Sustainability Aspects
Teaching and learning process and activities	Teaching learning approach	Project Based Learning: Collaborative working teams	Active and collaborative approaches are those that can help to promote sustainability skills.
	Activities	• Present the statement of the project and its context. • Choose the learning objectives. • Individual / group learning with the puzzle method • Individually analyse the elements of one of the supports and make the modifications. • Prepare the project document in group. • Defend in public the adopted solution.	• Answer a questionnaire on sustainability and SDGs. • Watch UNESCO etxea's video about SDG (the first one) and the video about SDG 15. • Analyse the websites of the distribution companies that have a section on sustainability (Iberdrola, EDP and Unión Fenosa) and review critically the sustainable activities carried out by the companies (in groups) • Analyse in groups what can be done in regarding to SDG 15 when designing lines, bring together results (at least two things must come out, birdlife and logging). Discuss the identity of the "sustainable designer" • Reflect on the role of the engineer with respect to the SDGs
	Resources	https://www.eitb.eus/es/noticias/sociedad/videos/detalle/6110667/video-nuevas-torres-alta-tension-evitar-aves-se-electrocuten/ Avifauna y tendidos eléctricos en la CAPV. Sáenz de Buruaga *et al.*, Gobierno Vasco, 2018. http://www.euskadi.eus/gobierno-vasco/-/documentacion/2018/avifauna-y-tendidos-electricos-en-la-capv/ Avifauna live Iberdrola v2 Experiencia adecuación de tendidos eléctricos. Gobierno de Aragón. BOPV/EHAO Resolución del 18 de junio de 2018, del director de patrimonio natural y cambio climático por la que se determinan las líneas eléctricas que no se ajustan a las prescripciones técnicas establecidas en los artículos 6 y 7 del RD 1432/2018 https://envertec.eu/avifauna.htm Template to write the project. Drawings and photographs of the line	1 and 15 videos of UNESCO etxea. https://www.youtube.com/watch?v=gQBJfYlDOvA & https://www.youtube.com/watch?v=1peW1UMNq1A https://www.iberdrola.com/sostenibilidad/comprometidos-objetivos-desarrollo-sostenible https://www.edphcenergia.es/es/sostenibilidad/ http://www.ufd.es/conocenos/medio-ambiente/ RD 1432/2008 de 29 de agosto, por el que se establecen medidas para la protección de la avifauna contra la colisión y la electrocución en líneas eléctricas de alta tensión. (http://www.f2i2.net/documentos/lsi/dis_6074.pdf)

Assessment of sustainability competences

To finish with the design of the activity, the rubrics designed to evaluate the learning objectives of sustainable development are presented below in Table 2. The questionnaires used to evaluate the contents related to SDG and sustainable development are not shown, because the authors consider that they have little interest in comparation with presented rubrics.

Table 2. Rubrics to assess sustainability learning objectives

Competence	Learning Outcomes	Level 1	Level 2	Level 3	Assessment Tool
Systemic thinking	Know and understand the relationship between the agents involved in the protection of birdlife (legislations, companies and SDG 15), and raise viable solutions with all conditions.	the student only applies the national bird protection legislation to justify the Project.	the student differentiates the national and regional legislations and justifies the Project based on both	the student differentiates national and regional laws and justifies based on them and the requirements of SDG 15 project.	Project document
		the student only applies the bird protection legislation to design the solution.	the student applies the bird protection legislation and the requirements of electrical distribution companies.	the student applies the bird protection legislation, the requirements of electrical distribution companies but also meets other questions of SDG 15.	Project document
Critical thinking competence.	Know and critically analyse the positions of the electrical companies regarding the SDGs and propose your own personal positioning as line designer.	the students make a list of the activities of the distribution companies for the SDG 15	After making the list of activities of distribution companies the student questions the quality of the actions of the companies with respect to SDG15	The student knows and values the actions of the companies with respect to SDG 15 and adopts his own speech regarding his own actions in sustainability.	Personal Reflection
Collaboration competence	Learn from other team members and collaborate with the team to get to do a viable project, overcoming conflicts and different points of view.	The student does his part of the work and does not consider the contributions of the rest of the mates	The student is responsible for his/her own learning and learn from others but doesn't teach	The student is responsible for his/her own learning and helps their team mates to learn.	Coevaluation
		The student is not respectful of the opinions of others and tries to impose his vision	The student is respectful of the opinions of the rest but makes no effort to reach agreements or solve the problems that arise	The student is respectful with the opinions of the rest of the group members, listens actively and tries to reach agreements	

References

1 UNESCO, Educación para los objetivos de Desarrollo sostenible, 2017

2 CRUE, *Guidelines for the Inclusion of Sustainability in the Curriculum*,2005 retrieved from http://www.crue.org/Documentos%20compartidos/Declaraciones/Directrices_Ingles_Sostenibilidad_Crue2012.pdf

3 Sáenz de Buruaga et al, *Avifauna y tendidos eléctricos en la CAPV*, Gobierno Vasco, 2018.

E-11

Addressing Sustainability Competencies in Engineering Courses: An Experience

T. Guraya*, E. Diaz, Z. Aginako, M.B. Peña-Lang and J. Albizuri

School of Engineering in Bilbao. (Spain)

**teresa.guraya@ehu.eus*

ABSTRACT

An attempt to introduce competences related to Sustainable Development Goals has been carried out in two materials engineering courses of an engineering degree. As part of the tasks in the semester, students worked in a problem-based learning activity. Mobile telephones and electric car were the core of the activities. Aside from the specific and soft skills described on the course guides, some points as raw critical materials, extreme conditions to extract some metals, the necessary use of hazardous materials and the environmental impact of consuming society where highlighted. Personal and common reflection on Sustainable Development Goals and the impact of technology and massive consume on them were promoted.

Introduction

The role of the University in society needs to adopt the changes that have taken place in the world over the past few decades. Kliksberg [1] states that "the University of the 21st century, the century of great technological opportunities, but at the same time of unacceptable social poverty and suffering, must reform itself technologically to become the basis for progress, but above all it must renovate its social responsibilities in order to be more than ever a reference in the construction of peace and justice for ordinary people". Regarding to university accountability on the formative process, the author indicates that "the university should prepare economists, administrators, doctors, lawyers, engineers and specialists in all fields, with a solid grounding in responsibility so that they can make decisions on the ethical dilemmas that they face with fundamental moral values and undertake service commitments to the weakest". In the same stream questioning the traditional paradigms are many other authors; Gasco-Pliego *et al.* [2], who demand professionals with a sense of social responsibility that questions economic rationality, competition without limit, and exacerbated self-interest, instead of promoting values such as solidarity, cooperation, equality, and mutual respect; Martínez [3] proposes that universities should become places for the transformation of people and society, enabling young people to acquire the competencies that citizens need to live sustainably, at personal, professional, and community levels. The definition of the University Social Responsibility proposed by Vallaeys [4] address concepts such as sustainability, equality, inclusion, gender or responsibility as part of the formative process and no longer belong exclusively to the personal sphere but also fall within the formative facet of the social impact of universities. Then, the traditional role of universities as places for the creation and transmission of knowledge has become obsolete and their place in the society of the 21st century has yet to be refined. In this context, the University of the Basque Country has the capacity to make a critical and constructive contribution to sustainable development and so do taking on the challenge of Sustainable Development Goals.

In a previous study, we found that active pedagogies as a project or problem-based learning were particularly successful in teaching core courses [5], which enables teachers to work effectively not only on specific competencies but also on the so-called soft skills with good acceptance by all the agents involved [6].

In this work, we present an experience carried out in two courses of an engineering degree. We took advantage of the particular circumstances of the small size of the groups of students to apply problem-based learning pedagogy and introduce teaching for sustainability competencies.

The Experience

This experience has been carried out in two 4.5 ECTS credits courses, Materials Manufacturing and Engineering of Alloys, both included in the curricula of the 4 years degree Mining Technologies Engineering and Energy. Since the third year forward, students choose their minor in Energy or in Mining Technologies. The course Materials Manufacturing is mandatory in the third year for students following the Mining Technologies minor and the course Engineering of Alloys is optative for both in the fourth year but for many years only students in the Energy minor choose it. Aside from these two courses, the background of all the students in materials engineering reduces to one common course (Materials Science) followed in the second year.

The degree in Mining Technologies Engineering and Energy has been lowering the number of inscriptions year by year, due to structural and temporary economic/industry issues in the country and, particularly, in the region. The actual inscription this year (2018-2019) was 3 students in the Materials Manufacturing course and 4 students in the Engineering of Alloy's course. That situation allows teaching differently from traditional speeches and so was done. Several visits to manufacturing plants, like glass bottles, polymer parts, iron casting, steel making and stone quarry were organized. Taking advantage of the number of students enrolled in the two courses, they visited the factories together. As part of the objectives of the courses, they learnt about industrial processes, equipment, maintenance tasks, regulation, standards etc. Aside from that, they were encouraged to gather information about sustainability policies applied in each factory, not only the environmental but family, gender, social responsibility policies and others. To work at the classroom a problem-based learning activity was proposed. Students enrolled in the Manufacturing Materials course had to study the problem of mobile telephone waste. They had to put particular attention into addressing materials in telephone parts and their manufacturing processes. Students enrolled at Engineering of Alloys studied the sustainable impact of the automotive transport transformation from gas-powered cars into electric-powered cars. Regarding the objectives of the course, students had to focus into alloys, differences among grades of steels used to build the car body and gear parts, cast alloys for engines and materials related to the car battery. In order to provide some guidance and methodology to assess the impact of the e-car development, students were suggested to read the white paper by Mike Ashby "Assessing Sustainable Developments: a summary" [7].

To address Sustainable Development Goals into the problems, the students dedicated the first lesson to read about it. During the semester they should select no less than 2 Goals which in their opinion were somehow related to the problems they were working on. As guidance, some suggestions were highlighted on raw critical materials. At the beginning and at the end of the experience students were required to make their own reflexion on some topics related to SDG.

Results

From the teachers' point of view, it was necessary to define competencies related to Sustainable Development Goals (SDG-C). What we defined were:

SDG C-1: To acquire the capacity to do the right analysis of the impact of their decisions regarding the efficient use of raw materials, particularly raw critical materials.

SDG C-2: To acquire the capacity to assess the impact and opportunity to apply the basic recycling principles: Reduce, Reuse, Recycle.

SDG C-3: To acquire the capacity to assess the impact of their decisions in third countries, in their labour markets, social justice, etc.

SDG C-4: To be competent in critical thinking when searching for information

Students worked autonomously during the semester with a weekly supervised session of 3 hours. After a first analysis of the problem in common, they organized the work, assigned tasks, made the planification along the semester and created a common place to share information and documents. Weekly they reported a summary of the group progress in a kind of meeting minutes template. Access to CES EduPack and its tool EcoAudit was provided to perform the Life Cycle Analysis (LCA).

Case 1. Manufacturing Materials course, 3rd year. The weight of the activity in the final mark was 60% as the course also includes construction materials, out of the scope of the problem. Students decided to study the electronic waste problem, its statistics and historical evolution and the impact of mobile telephones on it in the last decades. Afterwards, they choose one commercial terminal and searched for all the materials involved in manufacture. Using CES EduPack they learnt about primary production processes and recycling of materials as alternatives and performed the LCA. They realized of so many materials take part in this small, light and complex devices, and the difficulty of the proper recycling of all materials at the end of life. Aside from technical aspects, students learnt other things; the importance of being critical with the huge amount of information available at internet, the difficulty of gathering information from some countries or the amazing numbers that describe the disposal of mobile terminals daily in the world. They also search for information about the problem surrounding coltan extraction in RD Congo. Finally, students made a personal reflection on the impact of technology and massive consume in Sustainability.

Case 2. Engineering of Alloy's course, 4th year. The weight of the activity in the final mark was 100% because it gives the chance to cover the objectives of the course described in the guide. Students decided to make a comparative study of two cars and seek in the market a brand offering the same model gas and electric powered. They had to search into differences in mechanics of both cars and the resulting equality and differences in their parts. They also searched materials used, different steel grades, cast and wrought aluminium alloys, magnesium alloys and alloys being part of the battery. They learnt the manufacturing processes of materials for the automotive industry and performed the LCA for both cars. In order to assess the impact of e-car, the followed the five-step methodology proposed by Ashby: problem definition, identify stakeholders and their concerns, fact-finding, synthesis and reflection. Each of these steps made students (and me) facing new points of view of sustainable developments and realize that critical thinking is necessary before making any decision. Similarly to the other group, they search for information about cobalt condition as one of the critical and strategic materials and human problems surrounding the extraction from mines in RD Congo. They also faced the importance and difficulties coming from conflict of interests and how to affect political policies.

SDG number 8 "Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" and number 12 "Ensure sustainable consumption and production patterns" were agreed by all students as the objectives related with their work.

Conclusions

Competencies of Sustainability can be achieved by students enrolled in engineering studies. Courses related to materials science and engineering are a good opportunity to work SDG related competencies. And so would do other courses in engineering studies. The interdisciplinary common framework would be desirable in order to work together given a big picture to students on these competencies.

In this work, two problem-based learning activities were defined to allow students acquiring technical, professional and sustainability competencies simultaneously. While teachers perform the activities, a balance must be accomplished on how to guide students in their semester planification. The lack of time makes difficult to cover completely the technical objectives of the course worked in the guides, but in our opinion results make it worth. Due to autonomous learning, what students learnt about materials and processes remains longer. And personal and group reflections on sustainability values are successfully promoted.

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References

1. Kliksberg, B. Los desafíos éticos pendientes en un mundo paradojal: El rol de la universidad (The pending ethical challenges in a paradoxical world: The role of the university). Rev. CLAD Reforma Democr. 43, 63–82, 2009.
2. Gasca-Pliego, E.; Olvera-García, J.C. Construir ciudadanía desde las universidades, responsabilidad social universitaria y desafíos ante el siglo XXI (Building citizenship from universities, university social responsibility and challenges before the 21st century). Converg. Rev. Cienc. Soc.18, 37–58, 20011.
3. Martínez, M. Aprendizaje servicio y construcción de ciudadanía activa en la universidad: La dimensión social y cívica de los aprendizajes académicos (Service Learning and construction of active citizenship in the university: The social and civic dimension of academic learning). In Aprendizaje Servicio y Responsabilidad Social de Las Universidades; Universitat de Barcelona y Ediciones Octaedro S.L.: Barcelona, Spain, 2010; pp. 11–26, ISBN 978-84-9921-124-4.
4. Vallaeys, F. University Social Responsibility: A mature and Responsible Definition. In Higher Education in the World; GUNI (Global University Network for Innovation): Barcelona, Spain, 2013; pp. 88–96. Available online: http://www.guninetwork.org/files/ii.4_1.pdf (retrieved 28 March 2019)
5. L. Cabedo, M. Royo, L. Moliner and T. Guraya, University Social Responsibility towards Engineering Undergraduates: The Effect of Methodology on a Service-Learning Experience, Sustainability, 10, 1823, doi:10.3390/su10061823, 2018
6. Moliner, M.L.; Guraya, T.; Lopez-Crespo, P.; Royo, M.; Gamez-Perez, J.; Segarra, M.; Cabedo, L. Acquisition of transversal skills through PBL: A study of the perceptions of the students and teachers in materials science courses in engineering. Multidscip. J. Educ. Soc. Technol. Sci, 2, 121–138, 2015.
7. Sustainable Development Projects. Assessing Sustainable Developments – a summary, Mike Ashby, Granta Design Ltd. Teaching Resources, 2014.

E-12

Assessing the Impact of Transition Towards Sustainable Mobility: the E-Car Game

D. Lopez, J. Basarrate, T. Gutierrez, J.P. Gordillo, J. Albizuri, T. Guraya*

School of Engineering in Bilbao. (Spain)
*teresa.guraya@ehu.eus

ABSTRACT

We have studied the changes in materials and parts due to e-car development and we have also assessed the sustainability of the transition to electric car mobility. Nowadays the mainstream pushes to change automobile customers' habits to buy electric cars but before making a decision, critical thinking and professional assessment should be accomplished.

Introduction

The first day of class in the course Alloys Engineering, during the presentation the teacher proposed us to learn in a different way. Those two first hours she talked about Global Sustainability and Sustainable Development Goals and she instructed us in the use of CES EduPack software, particularly materials properties related to embodied energy, the EcoAudit tool to perform Life Cycle Analysis (LCA) and some white papers that explained how analyze and assess the impact of new technological developments following a five steps methodology [1-2]. Afterwards, the teacher suggested us to work differently, accomplishing the analysis of the impact in sustainability of the electric car; a tool to work simultaneously competencies related the contents of the course and to sustainability. The proposal was challenging and we accepted immediately.

Then in this course, we have analyzed the technical modifications developed for e-cars by comparison of two models of the same brand, one e-powered and the other gasoline-powered. We have also studied the impact in sustainability, including a Life Cycle Analysis of both cases and thought about which of the Sustainable Developments Goals would be affected by this development. The substitution of combustion engine by electric engine requires important modifications in the car, among them the use of critical and conflict materials, high capacity batteries or magnets with good performance. Moreover, the environmental impact of original source for the energy used in e-cars must be taken into consideration. Then a serious reflection on the actual impact in sustainability becomes necessary.

Aside from technical and sustainability related competencies we worked other soft skills. We worked in group, at the classroom supervised by the teacher and autonomously outside; we learnt to seek reliable sources for gathering information and to have critical thinking that allowed distinguishing facts from marketing; we had to improve languages skills because most information was in English, etc. To present our final report we created a game.

The Case

We started the work by reading the paper from Ashby on "Assessing the Sustainable Developments Impact" in order to learn how to apply his five steps methodology to assess the impact of electric transport transition in sustainability. The first task was to seek in internet a proper case to study, i.e., a car for which technical information of the electric and combustion models were available; and decided to use the Golf model manufactured by Volkswagen.

To manage the project tasks and schedule and to supervise a proper progress we chose the team leader. He was in charge of supervising that all the tasks were accomplished on time, writing the minutes of our meetings and contacting with the teacher when it was necessary. We also created an online common place to communicate, work and share information.

Afterwards we identified the following tasks to complete our case: learn how the electric car moves; find out technical differences between both cars; identify the metallic materials involved in both models; understand the existence of differences and trends in materials and processes due to weight difference among the two models; learn how batteries performance is calculated and the last advances in the field; and learn about magnetic properties of materials and their influence in the performance of the electric engine. Aside from those, we learnt how to perform a basic LCA of a product and we carried it out for the both models studied. We also researched who stakeholders involved in transition to electric mobility are, what the environmental impact of different sources of electric energy is and we tried to find information about the electric infrastructure necessary to support thousands of cars charging batteries simultaneously. Finally, we reviewed the European and National legislation affecting transition to electric mobility and we accessed to SDG website [3] and decided which of the goals are connected with our case.

Results

We studied the main differences between the two cars. The explosion engine makes the pistons move up down and the movement is transmitted to wheels. This process produces in several steps and as much as 80 % of energy can be lost. In electric cars the energy stored in the battery is converted into mechanic energy by means of magnets, what makes the engine move in a simpler way, improving efficiency significantly. These magnets contain rare earth metals (neodymium or samarium), critical materials whose performance depend on the coercive force (A/m) and remanent induction (T) of the materials. We also learnt that batteries include toxic metals as cadmium or lead and critical materials as lithium or cobalt. Batteries overall performance are assessed using different features, specific energy (MJ/kg), specific power (W/kg), cost, expected life, safety and performance. Currently, batteries base on Lithium Nickel Manganese Cobalt oxide show the best balance among all features. We also learnt that most cobalt mines are in RD of Congo and the ore extraction is source of human conflicts and abuses, directly related to SDG. The use of batteries increases the weight of the car about 15%. This creates an opportunity for steelmakers and car body makers for the development of new steels and processes that could allow reducing parts thickness. Nowadays, hot stamping processes are being used to shape car body parts on several generations of low alloy steels of high and ultrahigh resistance, dual phase or TRIP steels. Finally, the amount of cooper is much higher in electric car. Aside from those differences, both cars are mostly similar.

To compare the LCA of both cars we used a list of materials based in other works [1] that contain all the common materials used (metallic, plastic, elastomer and textile materials). We stablished a life duration of 10 years and 15K km per year. We found that when electric energy comes from Europe (averaged sources) reduction in emissions are of about 25% (CO_2 footprint, kg). When the estimation is performed with electric energy coming from Norway, the reduction raises up to 55%. This difference is due to the source of energy, mostly green in that country. But this analysis is incomplete; aside from that, it is necessary to take into consideration new metals contained in batteries and magnets. Some news and articles published by the European Environmental Agency [4] estimate an increase from 30% to 100% the environmental impact associated to materials and manufacturing processes in the electric car, but we were not able to find information to contrast this fact.

Finally, we identified stakeholders and their interest in the transition to electric mobility. Cars and battery manufacturers, governments (defending the interest of citizens as noise level, air quality, environmental care…. and promoting policies as diesel ban, e-car subsides….), labor unions (defending workload rights, training in new technologies), green lobbies and green activist. Each of them has interest and influence in the transition process and interact in many directions.

There were two points we wanted to highlight. We did not find reliable information about what happens when batteries reach end of life, secondary use is always an option but when it is not, recycle becomes necessary and there is not enough information of the process. Second we found lack of information about the electric infrastructure that would be necessary to provide good service for a massive transition to electric car; what would happen to the electric network at peak times when thousands of customers try simultaneously to charge their batteries.

To present our final report we made a game with two legs. In first leg, players have to locate stakeholders' cards in a stakeholder board, i.e., a chart with two axes, one representing stakeholders' interest (from low to high), and the other their power and influence(from low to high too). Players think about it and discuss the best place to locate the cards and add single headed and two headed arrows resembling interactions among them. In the second leg, players are provided with kind of comic bubbles containing facts related to the e-car development and a board representing a road to future; on the roadsides there are many road signals, red circles meaning "prohibition", red hexagons meaning "stop", blue rectangles meaning "recommendation" and red triangles meaning "danger". Players have to assign a type of signal to each fact and justify the decision.

Conclusions

Transition to electric mobility is mainstream in news and social networks. But before making a decision some point have to be regarded. First technology is new and in our opinion it is always better to wait for second or third evolution. Second, some of the metals involved in electric car technology are critical and, even more, cobalt is a conflict metal. The impact in SDG 8, 11, 12 and 13 must be taken into account. Third, effective batteries recycling is still under study. Fourth, despite de new advances in charging batteries types and modes (speed, connectivity to recharging infrastructure), the current infrastructures are not ready to charge thousands of vehicles simultaneously. Fifth, while the sources of energy remains mostly no green, the positive impact in terms of CO_2 footprint are possibly balanced by the impact of using more contaminant metals. We concluded it is not easy to make that decision, gather reliable information and critical thinking are absolutely necessary.

Aside from that, we want to say that when enrolling the course we actually expected to learn more about engineering of metal alloys. It was not so but we have learnt other interesting things about materials, mostly magnetic properties, uses for rare earth metals and we have acquired competencies related to sustainability.

Acknowledgements

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References

1. CES EduPack, Granta Design Ltd., 2018.
2. Sustainable Development Projects. Assessing Sustainable Developments – a summary, Mike Ashby, Granta Design Ltd. Teaching Resources, 2014.
3. https://www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible/ (retrieved 01-23-2019)
4. https://www.eea.europa.eu/es/articles/vehiculos-electricos-una-eleccion-inteligente (retrieved 03-04-2019

E-13

Insertion of Sustainable Development in the Degree of Electrical Engineering. A First Approximation

Zaloa Aginako*, Koldobika J. Sagastabeitia**, Miren T. Bedialauneta***

Engineering School of Bilbao UPV/EHU
*zaloa.aginako@ehu.eus **koldo.sagastabeitia@ehu.eus
***miren.bedialauneta@ehu.eus

Introduction

This paper shows a first approach to the inclusion of Sustainable Development (SD) in the degree of Electrical Engineering at the University of the Basque Country. It is not only a inclusion of learning content about SD in the degree's subjects, it also inserts the model of Education for Sustainable Development (ESD) to advance in the transformational objective that the model pursues, so that future Engineers leaving university possess the necessary skills to incorporate the sustainable development in their designs and daily practices in the area of Electrical Engineering. In this first approach some modules are included throughout the training program to work in different subjects some Sustainable Development Goals (SDG) linked to the contents of these subjects. The SD has been included in a transversal way so that the students do not perceive it as something added to the contents and procedures of the degree, but as another element of their formative path. Likewise, the model that is presented, has the particularity of incorporating the concepts of the SD through the SDGs that act as a common thread and give an integrating sense to the procedures and learning contents.

The Sustainable Development Goals and Education for Sustainable Development

The 2030 Agenda for Sustainable Development (2015) sets the 17 Sustainable Development Goals (SDGs) to be achieved by the 2030 year. These objectives are defined as follows in UNESCOb, (2017, p.6)

> The SDG address a range of social needs including education, health, social protection and job opportunities while tackling climate change and environmental protection. The SDGs address key systemic barriers to sustainable development such as inequality, unsustainable consumption patterns, weak institutional capacity and environmental degradation.

To achieve the SDGs education is a fundamental tool, and due to the transformational nature of the pursued objectives UNESCO itself proposes the use of the Education for Sustainable Development (ESD) model to promote the SDGs, arguing that the ESD model "empowers learners to take informed decisions and responsible actions for environmental integrity, economic viability and a just society for present and future generations…" (UNESCOb, 2017 p. 7)

ESD is a holistic and transformative educational model that defines not only the learning contents or learning outcomes, but also two other dimensions: the approaches and the learning environment that should be employed, and the social transformation dimension (UNESCOa p. 12). The four dimensions of the ESD are shown in figure 1 in a graphic.

Besides, UNESCO in the document *Education for Sustainable Development Goals* proposes the key competences necessary to develop the Sustainable Development Objectives. These are a set of generic skills that can be used in any context and educational level, key competences are shown in Table 1. But it also in the same document a series of specific learning objectives for each SDGs are proposed. This document is the basis used to design the inclusion of Sustainable Development in the Electrical Engineering degree described in this paper.

Figure 1. Dimensions of ESD (adapted from UNESCOa, 2014, p12)

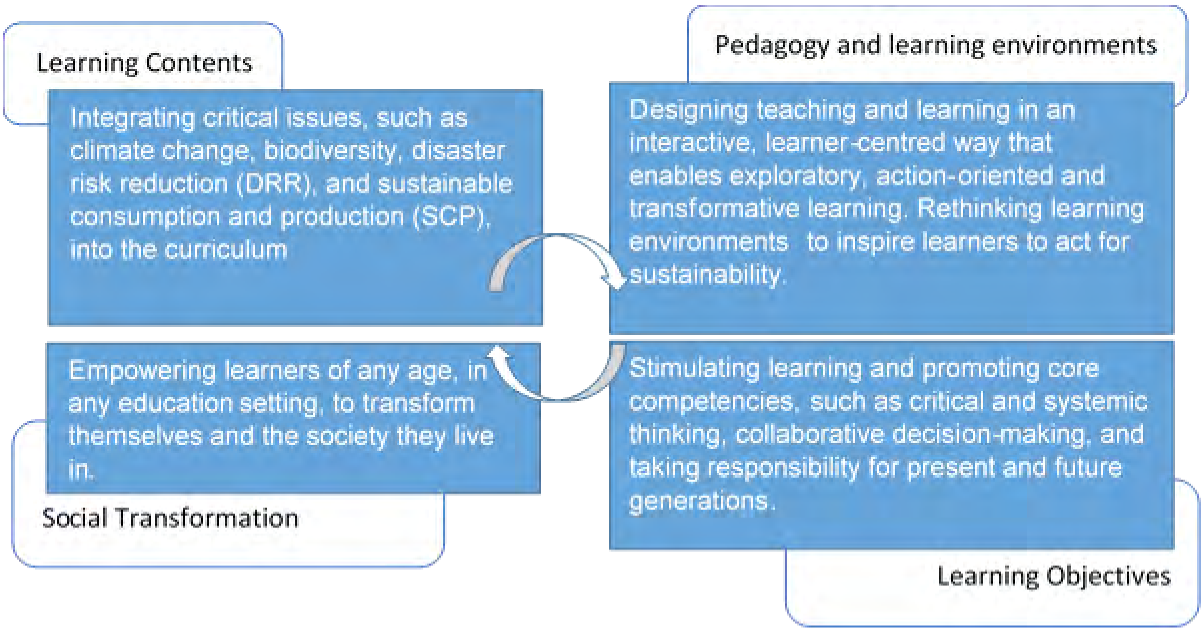


Table 1. ESD's key competences for the development of SDG (in UNESCOb, 2017 p. 11)

ESD-1 Systems thinking competency: the abilities to recognize and understand relationships; to analyse complex systems; to think of how systems are embedded within different domains and different scales; and to deal with uncertainty.
ESD-2 Anticipatory competency: the abilities to understand and evaluate multiple futures – possible, probable and desirable; to create one's own visions for the future; to apply the precautionary principle; to assess the consequences of actions; and to deal with risks and changes
ESD-3 Normative competency: the abilities to understand and reflect on the norms and values that underlie one's actions; and to negotiate sustainability values, principles, goals, and targets, in a context of conflicts of interests and trade-offs, uncertain knowledge and contradictions.
ESD-4 Strategic competency: the abilities to collectively develop and implement innovative actions that further sustainability at the local level and further afield.
ESD-5 Collaboration competency: the abilities to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, relate to and be sensitive to others (empathic leadership); to deal with conflicts in a group; and to facilitate collaborative and participatory problem solving.
ESD-6 Critical thinking competency: the ability to question norms, practices and opinions; to reflect on own one's values, perceptions and actions; and to take a position in the sustainability discourse.
ESD-7 Self-awareness competency: the ability to reflect on one's own role in the local community and (global) society; to continually evaluate and further motivate one's actions; and to deal with one's feelings and desires.
ESD-8 Integrated problem-solving competency: the overarching ability to apply different problem-solving frameworks to complex sustainability problems and develop viable, inclusive and equitable solution options that promote sustainable development, integrating the above-mentioned competences

Introducing sustainability in the Electrical Engineering Degree

The insertion of Sustainable Development (SD) in the university curriculum can be done in different ways, one of the ways is to include specific subjects on sustainability. However, some authors like Kaurd Anand, Bisaillon and Ben Amor (2016) defend the introduction of sustainability concepts throughout the curriculum so that it should be treated as another element of the formative path and not as an added subject. As Murga-Menoyo (2010) points out, it is not so much about broadening learning content, as it is about rethinking, integrating and transforming teaching, and orienting it toward sustainability.

In this particular case the transversal inclusion model has been adopted. Another element of this design is the use of SDGs as guideline. The use of SDGs has been chosen to students acquire a comprehensive vision of all the aspects covered by Sustainable Development and to give coherence to sustainability training.

One of the problems that can arise when integrating Sustainable Development into university curricula is to include, within the syllabus of each subject activities or topics related to the Sustainable Development. However, at this time, the opportunities to include content linked to the SDGs in the Electrical Engineering degree is not a problem, since many technologies are currently being developed that pursue precisely to minimize environmental impact, reduce electrical consumption and improve the effectiveness of electrical installations and devices. For example: the development of electric mobility, the integration of renewable energies in the electrical system, the management of electricity consumption and improving the efficiency of the network through smart grids, the efficiency of lighting systems and the installations of Low voltage, design and development of efficient electric machines, etc.

As has been commented above ESD is more than a mere definition of learning contents, the pedagogy and learning environment is defined as another of the dimensions of the ESD. The most appropriate approach is claimed as an active one, centred on students (see figure 1). In this regard it should be noted that the UPV / EHU promotes the use of a teaching-learning model which incises to focus learning on the student in an active process, thereby aligned with ESD.

Another key element in the inclusion of SD are the generic competences defined in the syllabus of Electrical Engineering degree, as there must be alinement between them and key ESD competences. Taking into account the SDGs chosen for this first approach of inclusion of the DS in the Electrical Engineering curriculum and after chequing the syllabus three generic competences has been chosen. Table 2 shows these generic competences and their correspondent key competences of ESD.

Table 2. Association between the competences of the ESD and the generic competences of the degree

Key competences of ESD	Electrical Engineering degree's Generic competences
ESD-5 Collaboration competency	C.14. Work effectively in a group integrating skills and knowledge to make decisions in the field of industrial engineering, electrical specialty
ESD-6 Critical thinking competency	C.7. Ability to analyze and assess the social and environmental impact of technical solutions.
ESD-8 Integrated problem-solving competency	C.4. Ability to solve problems with initiative, decision making, creativity, critical reasoning and to communicate and transmit knowledge, skills and abilities in the field of Industrial Engineering, specific electrical technology.

Model for the insertion of the SD in the Electrical Engineering curriculum

The model for the insertion of the DS in the Electrical Engineering curriculum has been made taking into account: the generic skills of the degree, the competences of the ESD and the SDGs. It also includes the level of achievement of the ESD from I to III, which will be evaluated with rubrics of three levels of achievement. In this first design the SDGs selected in the different modules are 12 (Responsible Consumption and Production), 3 (Good Health and Well-being), 11 (Sustainable Cities and Communities), 15 (Life on Land) and 7(Affordable and Clean Energy), which have been selected for their link to each subject. 15 modules have been designed that will be developed in 5 subjects of the degree. The level of achievement of the ESD competences have been assigned according to the learning outcomes pursued and the course. In table 3 the model is summarized.

Table 3. Description of the modules deployed in Electrical Engineering subjects

Subject (curse)	SDG	Modules	Activities	ESD Competences (achievement level)	Learning outcomes linked to SD
Power lines and systems (3º)	15	Birdlife protection	Carry out a project of an overhead line modifying poles to protect birdlife	ESD-5 (II) ESD-8 (II)	Know the impact that the OLs have on the birdlife and establish corrective procedures.
	15	Electric power transport lines	Analyze the environmental, economic and social impact of the construction of a power line	ESD-6 (II)	Argue against practices that cause biodiversity loss and establish corrective measures.
Low and Medium Voltage Installations (3rd)	11	Lighting calculations	Inclusion of energy saving criteria and regulations for interior and exterior lighting	ESD-5 (I) ESD-6 (I)	Include environmental requirements and understand the needed changes to do sustainable lightings.
Simulations and tests with electrical machines (4th)	7	Modeling and simulation of electric power systems with different sources (electrical machines)	Carry out simulations to optimize the use of machines with sustainability criteria based on the application of renewable sources	EDS-6 (III)	Analyze electric power systems by applying different scenarios with renewable sources and assess the impact of the use of these sources.)
	12	Modeling and simulation of electrical machines applications in electrical power systems	Develop guidelines for the redesign of machines in order to reduce the consumption of energy originated during its operation and reduce the environmental impact and apply them in the modeling / simulation	EDS-6 (III) EDS-8 (II)	Evaluate the impact of machine design and analyze the effects of the development of machinery redesign guidelines using sustainability criteria

Subject (curse)	SDG	Modules	Activities	ESD Competences (achievement level)	Learning outcomes linked to SD
Control of electric machines and drivers (3rd)	12	Electrical systems based on electric motors, electric drives and machine control.	Design of electrical systems based on electric motors through the application of electrical drives and control of machines applying energy efficiency measures with the aim of obtaining an environmental improvement	EDS-5 (II) EDS-6 (II) EDS-8 (III)	Perform designs of electrical systems applying the guidelines and criteria necessary to achieve improvements based on energy efficiency.
	12	Electrical systems based on electric motors, electric drives and machine control.	Design energy improvement strategies with a scope in the reduction of energy consumption and electrical systems material based on electric motors and develop the guidelines for the redesign of those systems.	EDS-5 (II) EDS-6 (II) EDS-8 (II)	Identify the guidelines to apply in electrical systems with the aim of reducing energy and material consumption.
Electric Machines	3	Safety and risk reduction in the use of electrical machines	Comprehensive analysis of electrical machines for a design focused on safety and minimization of risks for people and the environment (during its construction, life and withdrawal).	ESD-5 (I) ESD-6 (I)	Identify the risks in the people's safety and the environmental impact of electric machines in their integral cycle
	12	High performance motors	Study of electric motors from a energetic efficiency perspective	ESD-5 (I) ESD-6 (I)	Integrate energy efficiency criteria in the design and application of electric motors
	11	Electric motors for a change in the mobility model	Study of the motors specially adapted to their use in traction and electric vehicles. Comparison with the explosion engines.	ESD-5 (I) ESD-6 (I)	Know the current state of technology, future perspectives and compare the performance of the electric motor and combustion

References

1 UNESCOa, *Hoja de Ruta para la ejecución del programa de acción mundial para la educación del desarrollo sostenible*, 2014. Disponible online en: https://unesdoc.unesco.org/ark:/48223/pf0000230514_spa

2 UNESCOb, 2017, Educación para los objetivos de desarrollo sostenible. Disponible online en: https://unesdoc.unesco.org/ark:/48223/pf0000252423

3 Anand, C. K., Bisaillon, V., & Amor, M. B. (2016). *Confronting the challenges in integrating sustainable development in a curriculum: The case of the civil engineering department at Université de Sherbrooke (Canada)*. In Challenges in Higher Education for Sustainability (pp. 247-263). Springer, Cham.

4 Murga-Menoyo M.A., *Competencias para el Desarrollo sostenible: las capacidades, actitudes y valores meta de la educación en el marco de la agenda post 2015*, Foro de Educación, 13(19), 55-83, 2015.

E-14

Teaching methodology on sustainable development in primary and secondary education in Costa Rica

Bryan Eduardo Moncada Villegas

Instituto Tecnológico de Costa Rica (TEC)
bryanmoncada25@gmail.com

Introduction

This work aims to show the progress of the teaching methodology on environmental protection and the main effects it has had on the consciousness of students from primary education to higher education.

The issuance of regulations in the area of the environment in Costa Rica derives from the commitments that our country has assumed with greater force since 1992, the year in which the Rio Conference was held. The promotion of Costa Rica as a nation that protects its natural resources is part of a strategy to offer our territory as a destination for naturalistic tourism. Environmental education is a field of work that, in Costa Rica, developed more strongly since the nineties. The center of the activity developed by teachers in this area of studies has to do with the development of awareness and sensitivity in students, regarding the use, care and preservation of the environment. Emphasis is placed on attitudinal changes rather than unrestricted content evaluation. In the aforementioned period of time, Costa Rica has experienced a growing formation of non-governmental organizations that incorporate environmental education actions into their work. In addition to informative campaigns, preparation of didactic materials, research activities and incursions within the communities in environmental matters [1].

Environmental education is an educational proposal that opts to be political, critical and transformative, therefore, it finds in these contributions a rich source of knowledge that it is still necessary to deepen, assimilate and prove with community ecopedagogic experiences, in search of a better understanding and appreciation of the interrelationships of human beings with the environment [2].

It is necessary to face the magnitude of the environmental problems from a historical-political and philosophical perspective that allow you to clarify the structural factors with which you are working; must analyze the collective role of the recipients of environmental education and their possibilities for emancipation and influence in their environment; and it needs to delineate with certain clarity the foundations and educational, pedagogical and communicational models with which he works [3].

Environmental education is conceived as an inherent process in any educational space, leading to the formation of people awake to their reality and aware that they belong to a global ecological system, governed by a series of laws and principles that must be known and above all, be respected to guarantee life itself "[4].

Today humanity uses the equivalent of 1.4 planets every year. This means that it now takes a year and five months for the earth to regenerate what humans use in a year. The panoramas established by the United Nations suggest that if current trends in population and consumption continue in the next decade, we will need the equivalent of two lands. Turning resources into waste, faster than the time needed for waste to become resources, will produce a global ecological deficit, thus depleting resources on which human life and biodiversity depend [5].

Results and analysis

One of the most important conclusions of many of these studies is the fact that the conservation of biodiversity has a high degree of dependence on the acceptance and support provided by society and the group of human beings that comprise it. Thus, it becomes evident the importance that people have to know and appreciate its value, counting on the information and the adequate tools to carry out individual and group actions in favor of its preservation and mobilize individually and collectively as shown in figure 1 where Primary school children learn the value of protecting nature by example.

Figure 1. Children of primary education in environmental conservation class [6]

But in addition to this they must have the power to make decisions and adequate instruments to turn negative manifestations into positive situations for the preservation of life on the planet. The previous reflections give a deep meaning to the environmental conscience so that it is appropriate for the people and groups or social actors that make up a specific country or society. In this sense, environmental awareness takes a transcendent place in the application of the environmental policy of a country and ceases to be an accessory manifestation. Having a deep environmental awareness in the population, constitutes a fundamental wealth that goes beyond the reception of certain economic incentives to produce specific environmental results.

In a consistent way, the surveys show that people are in favor of the conservation of nature, that the deterioration of nature is a serious problem and that it thinks that something should be done about it, with urgency. It is a subject that has become a matter of concern for society as a whole and has ceased to be an exclusive thought of certain minority intellectual groups. The production and dissemination of scientific knowledge, and the special role in ecology, makes more and more people aware of the high human impact on the natural systems of the planet and the need to do something to control and reduce it.

An activity of great importance in the process of forming environmental awareness, as a social phenomenon, has been scientific and documentary dissemination through television, film, the Internet, radio and so-called "social networks". At present, the citizen handles a wide range of information from different sources and perspectives on the environmental issue, but also perceives the negative aspects of its management, especially those related to the contamination of water sources and their environment, global warming and to a lesser extent the effects on the reduction of biodiversity. Citizens' environmental opinion is more advanced than its consequent practices. This raises the need to find some valid explanations about this discrepancy between thought and action, to achieve a more complete approach to the phenomenon of environmental awareness.

Environmental awareness in Costa Rica is a pro environmental behavior, can be defined as that action that a person performs, either individually or in a collective scenario, in favor of the conservation of natural resources and aimed at obtaining a better quality of the environment, being these actions of deliberate and competent nature and forming part of a lifestyle, implying previous intention to make them. The determination of pro environmental action can be made taking into account two dimensions: the difficulty of the conduct development and the private or public nature of the behavior.

Thus, in the Ministry of Public Education of Costa Rica, MEP, environmental education is nowadays conceived as a component that forms part of the curriculum or educational design, through the transversal theme "Environmental Culture for Sustainable Development", which allows that the environment be studied in its ecological, sociocultural and economic components. The transversality is a pedagogical approach that is related to an education in values, as a teaching process with ethical foundation. The purpose of transversality is to develop competences in students, which are defined as an integrated set of knowledge, procedures, attitudes and values, which allows a satisfactory and autonomous performance in concrete situations of personal and social life. Although the competences are the same throughout the educational system, they must be developed in complexity and magnitude according to the social, physical and emotional characteristics of children and adolescents [7].

The competences developed on the transversal theme "Environmental Culture for Sustainable Development" in the students are the following:

- Apply the knowledge acquired through critical and reflective processes of reality, in the resolution of problems (environmental, economic, social, political, and ethical) in a creative way and through attitudes, practices and values that contribute to the achievement of sustainable development and better quality of life.
- Participates committed, actively and responsibly in projects aimed at conservation, recovery and protection of the environment, identifying their main problems and needs, generating and developing alternative solutions, to contribute to the improvement of their quality of life, that of others and sustainable development.
- Applies harmonious relationships with himself, with others, and other living beings through responsible attitudes and attitudes, recognizing the need for interdependence with the environment

Methodologically, the approach of the transversal theme "Environmental Culture for Sustainable Development" must be based on the innovation of didactic resources for the formation of skills, values, aptitudes and attitudes that promote responsible behaviors, habits and actions with the environment. The didactic resources are considered as objects that allow the construction of knowledge, through the relationship and interaction of teachers and students with said objects, within meaningful contexts of learning. It is also important that the topic be worked in an interdisciplinary way and in connection with the community, through the execution of specific projects for the identification of environmental problems, the search for sustainable solutions and the taking of appropriate decisions.

Starting from the consideration that environmental education is an education for discovery and action, it requires teaching methodologies that give equal importance to the analytical and theoretical approach of the scientific method, than to the more synthetic and practical approach to problem solving [7].

Conclusions

Environmental education for a sustainable and equitable society is a process of lifelong learning, based on respect for all forms of life. Such education affirms values and actions that contribute to human and social transformation in order to achieve ecological preservation.

Education must be directed towards participation, the development of thought and imagination; to foster a creative, critical, supportive attitude and respect for human rights, peace, the exercise of democracy and life in general; it must communicate environmental values and relate them to the productive characteristics, linking productivity, technological innovation, safety, occupational health and relations with the community.

With environmental education, each person and the community must internalize the knowledge in relation to environmental problems in such a way that they transform their behavior. In order to achieve attitude changes and promote and strengthen values in favor of sustainable development, actions should be carried out in an articulated manner, with a long-term defined intention. Finally, it is expected that with the Environmental Education in

Costa Rica, the citizens execute concrete actions to improve the environment, in a binding way with the legislation, the policies, and the measures of control and protection existing in the country; where the knowledge, values, behaviors and practical skills acquired for the prevention and solution of environmental problems are applied, through effective environmental management initiatives.

Therefore, it is necessary to build a new paradigm of society that puts on equal conditions economic growth, social inclusion, democratic coexistence and the preservation of natural conditions that allow the permanence of life on earth. This change of paradigm is possible insofar as important transformations take place in human beings in such a way that they reorient their consumption priorities, establish new production mechanisms compatible with the logic of nature and the environment, and adopt new forms of consumption and of commercial exchanges. That education, based on logical reasoning and critical thinking. it could help to change the utilitarian vision of the environment and adopt new ways of life compatible with its logic and respectful of its intrinsic value. The lack of correspondence between the initiatives adopted by most countries regarding the environment, its conservation and the adoption of sustainable development strategies, including environmental education; and the results that currently exist, could come from the incongruence between these purposes and a dominant economic model focused on obtaining maximum profit and excess consumption.

References

1. Muñoz, E. S. (2006). LA EVOLUCIÓN DE LA EDUCACIÓN AMBIENTAL EN COSTA RICA. Revista de Ciencias Sociales Universidad de Costa Rica, 71-80.
2. Nieto C., L. (2001). Presentación. En Dos Santos, J. y Sato, M. (Coord). (2001). A Contribuição Ambiental à esperança de Pandora. Brasil, Rima Editora.
3. Guilarte, P. S. (2010). Una experiencia de educación ambiental con estudiantes. Revista Electrónica Educare Vol. XIV, 167-176.
4. GUIER, E., 2000. Educación Ambiental: fundamentos, síntesis histórica en Costa Rica y algunos elementos para la integración al currículo. Programa Educación Ambiental, UNED s.p. (digitado).
5. Global Footprint Network. (10 de Febrero de 2016). Global Footprint Network. Advancing the Science of Sustainability. Obtenido de www. footprintnetwork.org
6. Hernán González Mejía, D. A. (2017). Sistematización del Proceso del Mejoramiento de la Conciencia Ambiental de Costa Rica. San José, Costa Rica.
7. Ferreto, M. A. (2013). Mejoramiento del Ambiente Urbano y Conservación del Ambiente Natural. San José, Costa Rica.

E-15

Mobile Telephones Waste in the Consumerism Society

A. Fernandez, K. Gonzalez, F. Lopez, J. Albizuri and T. Guraya*

School of Engineering in Bilbao. (Spain)

**teresa.guraya@ehu.eus*

ABSTRACT

In the course Materials Manufacturing we have studied the problem of mobile telephone waste. This work was proposed by our teacher; she wanted us to realize of the magnitude of the problem and how our consumerism habits impact on it. She always wanted to promote reflection on Sustainable Development Goals (SDG).

Introduction

We studied the "mobile telephone waste" case as one of the tasks of the course Materials Manufacturing. The mobile telephones contain plastics, glass, composites and metallic parts, each of them produced by different processes. Because of that, as the teacher pointed out, it is a good example to learn about materials manufacturing. Aside from that, it is a product familiar to us, contain some critical and conflict materials and it is a paradigm of the current consumerism society and planned obsolescence, features that allow us making a reflection on SDG [1].

The first week of the semester we were trained with CES EduPack software [2], a source of information of materials properties and manufacturing processes. It also contains a tool to perform basic Life Cycle Analysis (LCA), based on information about energy embodied in materials manufacturing, energy used to transport from the manufacturing place to the selling point and energy consumed by the product during its life.

To accomplish the objectives of the course we analyzed the mobile telephone parts focused in the materials and their manufacturing processes as well as the environmental impact. Aside from that, we analyzed the problem of electronic waste, its impact in sustainability and SDG. The course guide contents include other topics as they are agglomerate materials, machinery and equipment maintenance, then this task weighted the 40% in the course mark.

Study of the mobile telephone case

To contextualize the "mobile telephone waste" case, we decided that it was necessary to have the big picture of the problem of electric an electronic equipment (EEE) waste, its historic evolution and the contribution of mobile telephones to it. After gathering some facts that evidence the magnitude of the problem, we started the analysis of the materials and their manufacturing processes. We also learnt about the problem related to EEE recycling.

We studied the telephone history and the evolution of materials used, from the Bell's wooden telephone to the last smartphones. When looking through the manufacturing processes, we focused in the available sources for the materials (raw materials, recycled materials…) the use of critical or conflict materials, etc. Afterwards we performed basic LCA of three telephones; the oldest created more than 100 years ago, the traditional Bakelite telephones used for tens of years at our parent´s homes and a recent model of smartphone. We studied and compared the contribution of materials, manufacturing processes and use to the overall environmental footprint.

Finally, we made a reflection of the impact of this commodity and our of massive consumerism habits in sustainability, i.e. SDG, the dramatic increase of use and disposal of the product in the last years, the big problem associated to recycling of this materials and the use of conflict and critical materials.

Results

We learnt that the first facts about EEE waste comes from 1976, barely 50 years ago; it means than before then people were not concerned of the problem or were not able to aggregate and/or analyze this type of data. There are six groups of electric and electronic devices included in the concept EEE; telephones belong to the "Small IT and telecommunication equipment" category. In 2016, 44.7 millions of tons of EEE waste were generated in the world [3], which results in 6.6 kg per inhabitant. It represents the 70% of overall toxic waste in the world. It should be emphasized the existence of big inequalities among different countries around the world. Similarly to other developed countries, in Spain that year each inhabitant produced 459kg. of waste, 5% from it (25kg.) was EEE waste.

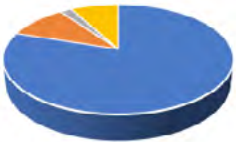
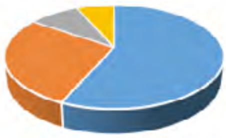
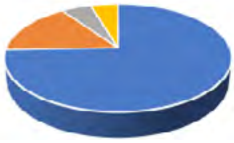
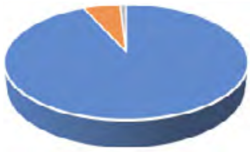
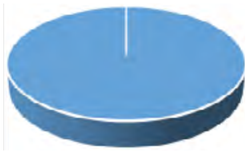
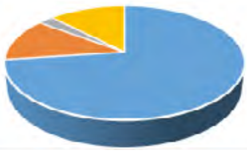
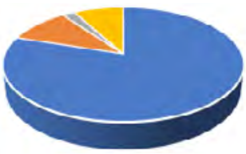
We found very interesting the development of the telephone, from the first models to current commodity, the evolution in product design. The first models developed by Bell more than 100 years ago only contained a block of wood for the base and small parts made with different metals, iron for the diaphragm, brass for connections, cooper wire to transmit the electric signals and isolating materials. A remarkable development occurred in the 20's when self-dialing telephones came out and polymeric materials as Bakelite started to be industrially used. This new material allowed making soft and warm surfaces, nice shapes and brilliant colors (product design). The next development came from the digital technology in the 80's, the portable telephone. It integrated simultaneously technological and materials developments; electronics came into the product and materials with new capacities were required. Since the last 20 years, mobile telephones became universal and almost a staple good; evolutions are being continuous until the last revolution, the smartphones, with touchable screen functions and incredible connectivity.

We found that manufacturing processes have changed noticeably as well. The first models were mostly handmade, wood basement was hand-shaped and metal parts were produced by casting or wrought processes. Bakelite telephones introduced the use of polymers and resin transformation processes (resin molding). New electric capacities required new manufacturing processes for metals and alloys. The latest developments come from the more complex functionalities provided by modern smartphones, which require dissipative uses of many metals. Mobile telephones use more than 20 different metals to achieve different functionalities; indium accounts for touchable screens, tantalum for capacitors that control peaks of heat and prevent damage in the printed-board's components, etc. Aside from that, LCD screens contain glass, covers are made mostly with thermoplastics and printed boards are composites made with many layers of different materials (glass fiber, resin, cooper layer, etc.). Glass transformation, sand casting, coatings, layer deposition, layer-by-layer sheet molding, welding and other are the manufacturing processes required to produce these telephones.

A point we want to highlight is the need of making a good use of the mobile telephones when reach the end of life. The three R rule (reduce, reuse, recycle) should lead the customer behavior but is looks far from being so. The current society based on massive consume does not seem to be able to change their habits, particularly in these technological gadgets. Recycling EEE waste is a big business and many works have been published on the topic [4]. It contains several metals, some are considered hazardous (lead) and others forming part of the circuits could be considered a source of raw materials ("urban mining" of copper, gold, zinc, beryllium, tantalum or niobium). Its recovery from EEE waste and particularly from telephones in complex; they come in traces and usually mixed. It still have to deal with doing this recovery in an economically viable way. Batteries recycling seem to be a big issue but we were not able to fin reliable information on this topic.

We did basic LCA of three telephones. Model by Graham Bell created in 1876, Model 5522A by Telefónica sold in 1950 contained and Model LG G5 in market in 2016. The contribution of each step to the total footprint is shown in graphics contained in table 1. We found out materials use to build each of the models at different sources. For Graham Bell telephone we sought at the National Museum of American History [5]: 2 kg of wood, 0.05 kg of cast brass, 0.250 kg of wrought iron and 0.1 kg of mica. Materials used in 55222A Telefónica model were found after deep and hard digging in several internet websites and even so, our facts are quite approximated: 3 kg bakelite, 0.5 kg of iron alloys, 0.1 kg of cooper alloys and 0.5 kg of isolators, textile and others. Finally, the smartphone LG G5 technical information provided a full description of all components and their weight, that we organized as follows: screen 0.059 kg, battery 0.041 kg, integrated circuits 0.01 kg, printed wiring board 0.035 kg and several plastics 0.011 kg.

Table 1. Details of LCA for three representative models of telephone at different time in history

Model	Graham Bell 	Telefónica 5522A 	LG G5 
Materials Code colours for footprint contributions	Wood, Iron, Brass, Isolator	Bakelite, Steel, Cooper/ Brass, Isolator	Cover, Battery, small integrated circuits, PWB, LCD screen
Mass	2.5 kg 	4.1 kg 	0.160 kg 
Materials % CO_2 footprint	2.1 kg CO_2 	7.5 kg CO_2 	12 kg CO_2 
Process % CO_2 footprint	0.24 kg CO_2 	7.2 kg CO_2 	0.0027 kg CO_2* 
Transport % CO_2 footprint	----	0,44 kg CO_2 	5.5 kg CO_2 
Use % CO_2 footprint	----	----	5.5 kg CO_2
Disposal % CO_2 footprint	0.035 kg CO_2 	0.078 kg CO_2 	0.0022 kg CO_2 
EoL % CO_2 footprint (potential + effect)	----	1.1 kg CO_2 	11 kg CO_2 

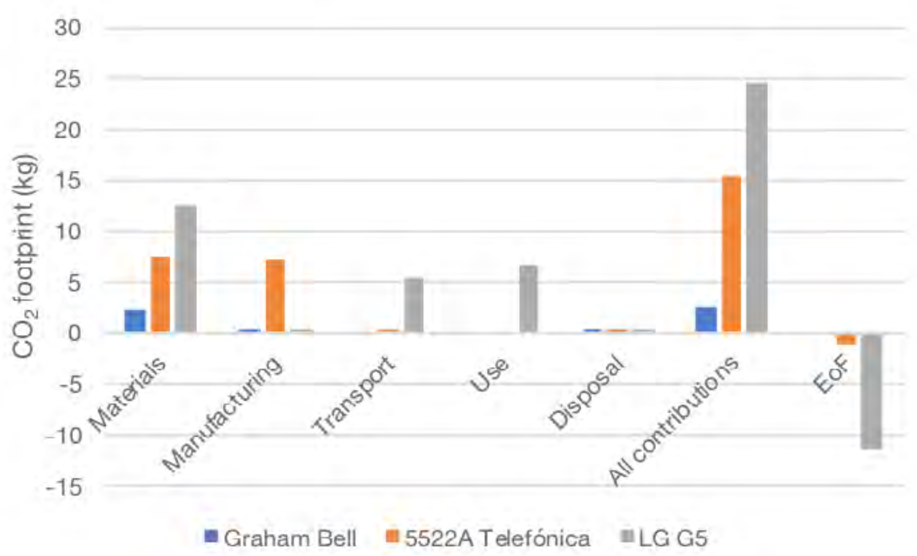
* for others but are plastics included in materias

* for 2 years of use, 365 days per year, 4 hours per day

Figure 1 summarizes the information worked out from the three LCA. The environmental impact associated to materials embodied energy raises dramatically as technology progresses. It is clearly due to the use of new and more contaminant materials. The contribution of manufacturing processes in only significant for the 5522A mode. The Bell's telephone is so basic that its impact is barely noticed and the smartphone is so small compared to the others that the impact of manufacturing of single one unit can be discarded, but should be noticed that in 2016, 1500 millions of mobile telephones were sold in the world. To calculate the impact of transport from manufacturing country to a selling store we assumed that Bell's telephone were manufactured nearby, 5522A inside a 1000 km ratio and the mobile somewhere in China. As consequence, the highest impact by far is for this last model. We have regarded that only mobile telephones consume energy while working and we did not find reliable facts about recycling as we explained before.

AS conclusion, the impact of all contributions to environmental impact per telephone unit results in 2.4, 15.2 y 24.5 kg of CO_2 footprint. As we stated before, in year 2016, 1500 million of telephones were sold; then the impact of the smartphones manufacturing and use in one year can be estimated very roughly as 36.75 billons of kg of CO_2 footprint. Just with the aim of comparison, the teacher gave us some figures worked out for another group of students. A familiar car powered by gasoline, in 1 year and 25000 km produces an impact of 7000 kg of CO_2 footprint. Then 4,5 millon cars, gasoline powered, driven for 25000km generate the same impact than the 1500 millon of new smartphones manufactured, sold and used every year!

Figure 1. Summary of the three LCA



The potential positive footprint of one smartphone model is of about 11,4 kg of CO_2 footprint (16.5 billons of kg of CO_2 footprint generated by the 1500 million produced and sold in one year), a reduction close of 50% of the primary use impact. Then the big issue is to become this potentiality into true, make the urban mining a source of raw materials. Even though, a serious reflection about our consume habits should be done. Finally we want to say that we learnt, and are now concerned, about the problem with coltan ores in RD Congo, the human conflict, the illegal extraction and commercialization of coltan and the horrible direct consequences to local population and indirectly to global society. SDG have a new meaning for us.

Acknowledgements

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References

1. https://www.un.org/sustainabledevelopment/es/objetivos-de-desarrollo-sostenible/ (retrieved 01-23-2019)
2. CES EduPack, Granta Design Ltd., 2018.
3. Baldé, C.P., Forti V., Gray, V., Kuehr, R., Stegmann,P. : The Global E-waste Monitor – 2017, United Nations University (UNU), International Telecommunication Union (ITU) & International Solid Waste Association (ISWA), Bonn/Geneva/Vienna.
4. D. Queiruga*, J. González Benito, G. Lannelongue, Evolution of the electronic waste management system in Spain, 2012, *Journal of Cleaner Production* 24, 56-65
5. https://americanhistory.si.edu/collections/search/object/nmah_704159 (retrieved 04-12-2019)

G

Engineering and gender/diversity

G-1

SHE-TIMELINE: To the Rescue of the (in)visible pioneers of technology

SHE-TIMELINE: Rescatando a las pioneras (in)visibles de la tecnología

M. Núria Salán[1]*, Dídac Ferrer[1]**, Marta Gil[2]***, Ana Freire[3]****

[1] Universitat Politècnica de Catalunya-UPC
[2] (Digital Marketing Specialist,
[3] Universitat Pompeu Fabra
*nuria.salan@upc.edu **didac.ferrer@upc-edu
***mgil@servihabitat.com ****anafreire@upf.edu




ABSTRACT

By reviewing the inauguration data of universities around the world, it is easy to see that access has been very different for men and women. Sometimes, this difference is a few decades but centuries in some cases between university inauguration data and when, for the first time, a woman in classroom. By checking about pioneer women in technology, when compared with first men in technology, the differences are much more remarkable.

Currently, there are men and women in engineering, all over the world, but population data are still far from-peer percentages. From the data collected in a survey about the first women graduates in STEAM (Science, Technology, Engineering, Arts-

Architecture, Math) an animated time line allow to visualize the location of these pioneers over time. With this exercise, it should be possible to visualize how inclusive or conservative our universities have been, when compared with its homonyms from all over the world. When everything is done, everything is still to be done…

Keywords: gender gap, equality policies, women pioneer in engineering

RESUMEN

Al revisar los datos de inauguración de las universidades de todo el mundo, es fácil ver que el acceso ha sido muy diferente para hombres y mujeres. A veces, esta diferencia es, en muchas ocasiones, de algunas décadas, pero en algunos casos han pasado siglos entre la fecha de inauguración de la universidad y el momento en que, por primera vez, una mujer está en sus aulas. En cuanto a las pioneras de la tecnología, al compararlas con los primeros hombres de tecnología, las diferencias son mucho más notables.

Actualmente, hay hombres y mujeres en ingeniería en todo el mundo, pero los datos de población aún están lejos de ser paritarios. A partir de los datos recopilados en una encuesta sobre las primeras mujeres graduadas en STEAM (Ciencia, Tecnología, Ingeniería, Diseño-Arquitectura y Matemáticas), una línea temporal animada permite visualizar la ubicación de estas pioneras a lo largo del tiempo. Con este ejercicio, debería ser posible visualizar qué tan inclusivas o conservadoras han sido nuestras universidades, en comparación con sus homónimas de todo el mundo. Cuando todo está hecho, todo está por hacer…

Palabras clave: brecha de género, políticas de igualdad, pioneras en ingeniería

Introduction

The lack of models is closely related with the lack of vocations. The engineering models in textbooks are mostly male, that's the main reason about traditional loss of female talent, since young people surely know hundreds of engineering/technology examples in which the role play (those who explain technology, those who have created things and/or patents, those who appear in the books, those who tell the history of technology) is carried out by men (1-4).

By asking an audience of 10-12 years about what engineering is, more or less accurate answers should be get, but someone always relates engineering to patents and/or problem solving. In same scenario, by asking the name of an inventor, it is easy to get names like Edison, Guttenberg, Franklin, Zuckerberg, Gates, Jobs, etc... They will be more or less successful, but usually first name of all provided surnames it's from a man. By asking explicitly about a female inventor's name, Marie Curie will clearly be the winner (and then, it's time to expose the difference between Science and Technology[1]) and a very

[1] *Theodore Von Karman: "Scientists discover the world that exists; engineers create the world that never was."*

common situation is about they cannot give any female name associated with a patent or technological creation.

This is happening in 2019.

In the field of games for children under 15 years old, male models are also common and this situation has been tried to regularize in last years. Thus, LEGO® has been introducing female figures in its games while other brands, such as Playmobil®, have resisted this change more, citing “commercial reasons” (Fig. 1).

Figure 1. Female characters in LEGO® and Playmobil®

5 NASA women in LEGO® characters: from left to right, Margaret Hamilton, Katharine Johnson, Sally Ride, Nancy Grace Roman y Mae Jemison[1].

Playmobil® characters created by TeatroClick as a complaint in the absence of female models in commercial games[2]

A case to be highlighted is TimeLine® game, consisting of an activity card set related to events, inventions or historical topics, among others, in which cards must be placed chronologically ordered. In three travel editions shown in Fig. 2, cards with human representation have been selected, and under each version, how many of the cards include an unequivocally female model/figure has been indicated. Optimal case is 5 and worst case is 0.

[2] https://www.elperiodico.com/es/extra/20170302/lego-homenaje-mujeres-nasa-5871547
[3] https://www.playgroundmag.net/now/La_22668234.html

Figure 2. Female characters in 3 Timeline® card set travel editions

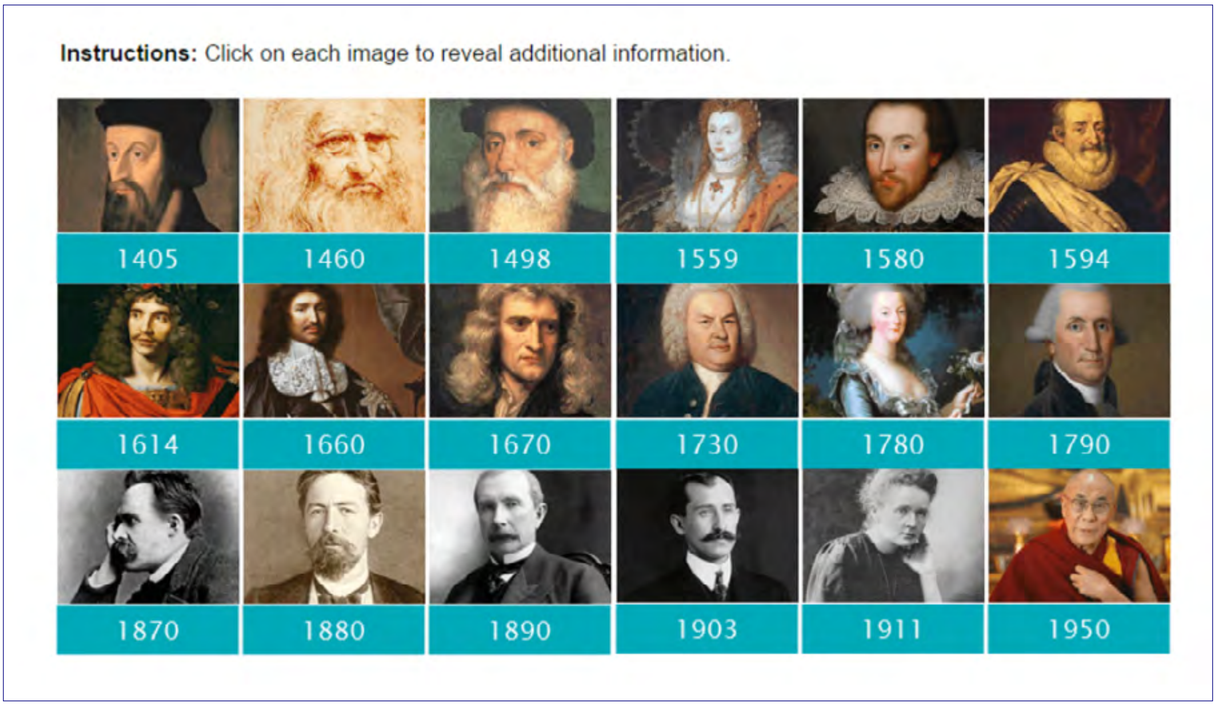

"Classics" edition card set, in which, from 55 cards, only 5 got female characters.


"Events" edition card set, in which, from 55 cards, only 5 got female characters.


"Invention" edition card set, in which, from 55 cards, none of them got female characters.

In this context, historical Timelines already existing in networks have been consulted, and it has been appreciated that the models are mostly male in all cases (Fig. 3).

Figure 3. **Historical characters timeline**



Timeline proposal

By consulting www.histropedia.com website, more than 3000 Timeline based on a multitude of topics have been identified, and in between there is one based on famous scientists, mostly formed, again, by male models. (Fig. 4).

Figure 4. Timeline of Famous Scientist in which 100% of models are carried out by a man (www.histropedia.com)

This website includes a women of science Timeline, that redirects to "women in science[4]" Wikipedia, but none on women of technology (engineering, inventions, patents) has been found. Hence, in this work, SHE-TIMELINE development has been proposed, consisting on an interactive timeline in which the names women involved in science and technology history, as well as pioneers in technology, from universities around the world (first graduates, first full professors, etc.) will be showed.

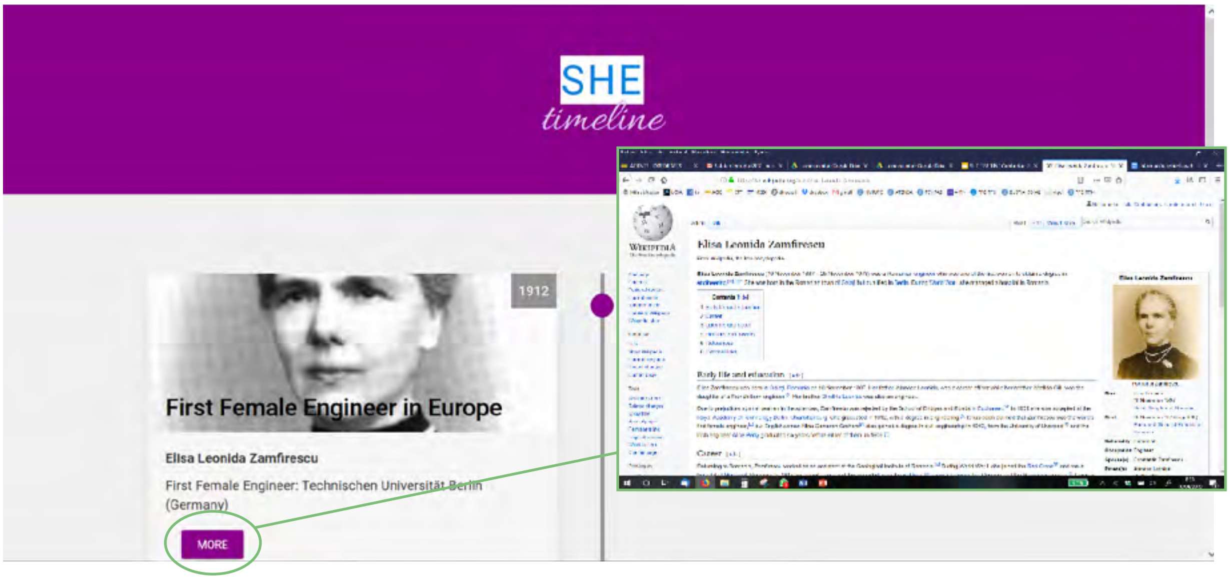
At the starting point on the search of contents, difficulty of locating that women name who should configure this SHE-TEAMLINE, by a conventional search (google, networks, even on universities websites), arises as an evidence, since many of these names are not known or published.

That is the reason why a google-form design has been considered[5], asking about pioneers, inventors and relevant women nominated to be included in SHE-TEAMLINE, and this form would be sent to as many universities as possible, all over the world, so that they contribute to give visibility to women from their respective environments.

The form has been prepared in such a way that the results are automatically published in a digital version, so that the feedback is immediate and the results of the collaboration are appreciated immediately. In all the cases, Wikipedia link of woman character is included in timeline (Fig. 5).

[4] https://en.wikipedia.org/wiki/Women_in_science
[5] https://forms.gle/yTE69ogdm8bN1GTw9

Figure 5. SHE-TEAMLINE with link to character Wikipedia



SHE-TIMELINE's approach is to collect data collaboratively, it means, from the contributions that are incorporated by supporters from anywhere. In order to encourage participation, it is offered to give visibility to the names of the collaborators, if they adopt a role of SHE-TEAMLINE's ambassadors with different levels (bronze: if they nominate between 1 and 5 women, silver if they nominate between 6 and 10 women, gold if they nominate between 10 and 25 women, platinum if they nominate more than 25 women). They can also adopt just a collaborator role, if they prefer anonymous collaboration, without their name being recorded.

By giving visibility to these women, conveyed message is "women have ALSO been important in engineering and technology development", and "women achievements have ALSO been worth noting", even though their presence have been denied in textbooks and/or in the relationship of historical figures. With this visibility, in addition to doing justice, to attract female talent is pursued, because, until now, any girl who had an interest in a technological path could only have access to engineering from models of example and/or success mostly male (5,6).

The data published in SHE-TIMELINE can be segregated by STEAM areas, or by countries, or by other topics, and can be used for a variety of purposes, such as for study promotion activities, for gamification or for dissemination.

The main advantage of SHE-TEAMLINE's "on-line" is the possibility of women contribution increasing in real time and at any time, without the need to accumulate data for updates.

Conclusions

The historical invisibility of women of science and technology has been the main reason why many generations of women have not considered this option as a possible future life.

The subliminal message of this invisibility has been that science, and especially technology, was not suitable for women.

By rescuing the names of women who have contributed significantly to current technology, in one way or another, it provides, in addition to historical justice, a necessary visibility so that they can be part of the examples of future generations.

SHE-TEAMLINE is, in addition to a timeline, a stage from which to put a voice and a place in history that, in many cases, up to now, has been denied.

References

1. Castillo R, Grazzi M, Tacsir E. Women in science and technology. What does the literature say? Technical Note No. IDB-TN-637 (2014) https://goo.gl/xY4d2F
2. Ceci SJ, Williams WM, Understanding current causes of women's underrepresentation in science. Proc Natl Acad Sci USA 108:3157-3162 (2011)
3. https://elpais.com/economia/2018/03/12/actualidad/1520852166_770315.html
4. https://elpais.com/elpais/2018/02/26/album/1519649002_373020.html
5. Verdín, D.; Godwin, A.; Kirn, A.; Benson, L.; Potvin, G. Engineering Women's Attitudes and Goals in Choosing Disciplines with Above and Below Average Female Representation. *Soc. Sci.* 2018, *7*, 44. doi:10.3390/socsci7030044. https://www.mdpi.com/2076-0760/7/3/44/htm
6. LaForce, M.; Noble, E.; Blackwell, C. Problem-Based Learning (PBL) and Student Interest in STEM Careers: The Roles of Motivation and Ability Beliefs. *Educ. Sci.* 2017, *7*, 92. doi:10.3390/educsci7040092. https://www.mdpi.com/2227-7102/7/4/92/htm

G-2

Inclusion of gender perspective in subjects of the degree in mechanical engineering

María Inmaculada Tazo[1], Saioa Etxebarria[2]*, Amaia Calleja[2], Ana Boyano[2], Amaia Mesanza[3]

[1] Departamento de Máquinas y Motores Térmicos, Escuela de Ingeniería de Vitoria-Gasteiz, Nieves Cano, 12, 01006, Vitoria-Gasteiz, Spain
[2] Departamento de Ingeniería Mecánica, Escuela de Ingeniería de Vitoria-Gasteiz, Nieves Cano, 12, 01006, Vitoria-Gasteiz, Spain
[3] Departamento de Ingeniería Minera y Metalurgia y Ciencia de los Materiales, Escuela de Ingeniería de Vitoria-Gasteiz, Nieves Cano, 12, 01006, Vitoria-Gasteiz, Spain
**Corresponding author: saioa.etxebarriab@ehu.eus*

ABSTRACT

This paper introduces the ongoing Educational Innovation Project (EIP) that is being carried out at the Faculty of Engineering of Vitoria-Gasteiz (Basque Country University, UPV/EHU, Spain). The proposed project consists in the inclusion of gender perspective in several core subjects of the 3rd course of the Degree in Mechanical Engineering. For this purpose, each subjects' competences are classified based on the *provision* and *care* nature in order to analyse and classify the transversal competences and the teaching-learning methodology of each subject. Moreover, visibility is given to women who have contributed to the development of theoretical concepts or practical methods related to the subjects involved in this study. Finally, mixed working groups are created to reinforce the value of diversity of viewpoints and ways of working and the influence that different aspects that are studied can have in people are incorporated in the subjects.

Introduction

The proposed innovation of the project consists in the inclusion of gender perspective in several core subjects of the 3rd course of the Degree in Mechanical Engineering at the Faculty of Engineering of Vitoria-Gasteiz, after completing a diagnosis of them. In recent years, the analysis of university degrees from a gender perspective, the study of the impact of sexism and gender relations in university education have gain a great interest [1], [2], [3], [4]. Gender perspective can be define as the study of men and women cultural and social constructions, which serve to define the masculine and the feminine. This analysis focuses on the inequalities between men and women [5].

In order to remove any form of discrimination of women, the study and analysis of the gender in the superior education system, especially in the most masculinized areas, is indispensable. The contribution of the University is essential to train people who contribute to this transformation, from the knowledge of the situation and consequences. Several laws has mentioned Gender equality at University. The Organic Law 6/2001 (21-12-2001) modified by the Organic Law 4/2007 (12-04-2007) states "University role as an essential transmitter of values… to achieve a tolerant and egalitarian society, in which the fundamental rights, freedoms, and equality between men and women are respected" (preamble paragraph 12) [6]. More recently, law 14/2011 (01-06-2011) of Science, Technology and Innovation, considers adequate for the development of Science in the XXI century "the incorporation of the gender approach with a transversal character" (preamble) [7].

The low participation of women in Science, Technology, Engineering and Mathematic studies (STEM) has been identify as one of the main problems that need to be solved to eliminate the gender gap in the technology area. According to the last report *Data and figures of the Spanish University system of the 2015-16 course* published by the Ministry of Education, Culture and Sports, the 54.1% of the students are women. The presence of women is the majority in all fields, with the exception of technical degrees. The highest percentage of women is 67.4% in Health Science and the lowest 25.8% in Engineering and Architecture. These figures have been stable for the last 10 years.

Regarding the figures related to the Engineering and Architecture field in the University of the Basque Country (UPV/EHU), the presence of women is very different depending on the type of degree, being the lowest in the traditional engineering related studies. The percentage of women in the Degree of Mechanical Engineering is 14.62%, while the 57.84% of the students in Environmental Engineering are women.

According to many researchers [8], [9] youth believe that the equality between men and women exists already. This phenomenon has been called mirage of equality, and it pretends to explain the presumed situation of formal equality that is perceived by the society, but it does not adjust to reality. Therefore, it is vital to arouse interest in the gender matter at the university field. Considering these facts, the purpose of the Educational Innovation Project (EIP) that is carrying out in the Faculty of Engineering of Vitoria – Gasteiz, is to progress in the achievement of equality.

Description of the Educational Innovation Project

The main objective of this project is to include the gender perspective in several subjects of the 3rd course of the Degree in Mechanical Engineering. The incorporation of the gender perspective is considered to have a positive impact in the acquisition of learning results related to team work; proposal development and discussion of different ideas, as well as the in the capacity of assessing solutions from a social sustainability point of view, considering people as object and subject of study.

The project intends to follow the line of the IKD model of teaching-learning[1] process, which is a UPV/EHU´s own model, cooperative, multilingual and inclusive that emphasizes that students are the owners of their learning with an integral, flexible training adapted to the needs of the society. The subjects in which the project is being applied are taught in Spanish, Basque and English. The EIP work team is compound by teachers, laboratory staff and a student of these subjects. The project is planned in two phases that coincide with the academic courses (2017/2018 and 2018/2019) in which it will be developed. The activities realized in each phase are summarized in Table 1 and Table 2.

- Phase 1: Project approach, team building and gender diagnosis of the subjects.

Table 1: activities related to the phase 1

Phase 1	Activities
	• Training on gender studies • Evaluation of the competences and methodologies and classification according to provision / care • Quantitative diagnosis of students and teaching staff of the 3rd course from a gender perspective • Qualitative study of the subjects, analyzing the transversal competences and methodologies according to the activities of provision and care • Analysis of the language used in the materials used in class

- Phase 2: Implantation of the gender perspective in the subjects, modification of the content and the teaching methodologies, giving visibility to the contributions of women in the theoretical concepts or in the practical developments that are studied in the subjects and making known the problematic found.

[1] https://www.ehu.eus/es/web/sae-helaz/ikd

Table 2: activities related to the phase 2

Phase 2	Activities
	• Information related to the gender system and the problems associated to it was given to the students • Problem solving not only considering the technical point of view but also the social influence of the solution • Parity was achieved in the talks that student receive in companies • Women´s knowledge and their social and historic contribution was integrated • Once the current academic year has ended the materials to be used in the classroom and laboratory practices will be modified with the aim of using an inclusive language that will avoid the generic masculine as much as possible • A publication is being developed based on the work of the project

Results

The quantitative diagnosis has been made, analysing the number of female and male teachers of each department of the faculty of engineering of Vitoria - Gasteiz, and number of lecturers of each department that teach in the 3rd course. There are 4 different departments teaching in this course: Mechanical Engineering (D145), Graphic Expression and Engineering Projects (D136), Nuclear Engineering and Fluid Mechanics (D149), and Machines and Thermal Engines (D148).

Table 3: presence of women in the 3rd course of Mechanical Engineering (course 2018/2019)

Depart*ment*	Female lecturers / department	% *departament*	Female lecturers in 3rd Spanish course	Female lecturers in 3rd Basque course
D145	4	40%	0	4
D136	0	0%	0	0
D149	1	25%	0	0
D148	1	33%	1	1

As shown in Table 3, the departments that teach in the 3rd course are clearly masculine in number, since the presence of women does not achieve the 50% in none of them. Moreover, one of the female teachers in both Mechanical Engineering and in Nuclear Engineering and Fluid Mechanics, have an associate contract which means that they are lecturers part time. It is worth mentioning that the students that study the degree in Spanish only have one female lecturer, whilst in the case of the students that study in basque, all the subjects but 2 are taught by female lecturers.

The competences of the subjects under the study of the EIP have been analysed and it has been considered that some competences are more appropriate for the realization of activities of care, that socially have been attributed to women and others are more adequate for activities of provision, socially attributed to men [10]. Instrumental linguistic, interpersonal and systemic opening personal competences are commonly attributed to activities related to people´s necessities (care). Instrumental cognitive skills, instrumental technical-scientific and systemic impact personal, are generally considered activities of preparation and provision of resources, and control of the environment (provision).

After the analysis, it is observed that the 88% of the generic competences are related to provision, thus close to the masculine stereotype. In the case of transversal competences, the 29% are related to provision. Therefore, one of the actions to achieve equality is to encourage the use of active methodologies for the acquisition of the care competences, in both generic and transversal competences.

With the objective of using an inclusive language that will avoid the use of the generic masculine, students guides of the subjects of this study have been reviewed, taking as a reference the "Guide to inclusive Spanish use" published by the Direction of Equality of the UPV/EHU[2]. The "Quick guide for inclusive language use" has been distributed among the students so that they can use it when needed to write the reports.

In order to integrate the knowledge of women and their social and historic influence, contributions such as the ones by Emily Warren, Olive Dennis and Margaret Ingels have been added to the corresponding subjects' materials. In parallel to this activity and with the objective of giving visibility to female engineers, in March, a competition where 3 questions regarding women with relevant contributions to engineering subject where sent through social network in the faculty of engineering of Vitoria – Gasteiz.

Conclusion

This work presents an Educational Innovation Project in its second year of implementation, which is being carried out at the School of Engineering of Vitoria-Gasteiz (University of the Basque Country, UPV / EHU). Its objective is the inclusion of the gender perspective in the 3rd year of the Degree in Mechanical Engineering. The gender diagnosis of the situation reflects a male environment in the classrooms, both in the number of lecturers that teach in the subjects and number of students in the classroom. Besides, the study of the competences shows that the degree is focuses mainly in activities of provision, with the objective of achieving, instead of in activities of care, focused on covering the needs of people.

The contribution of women in the technical fields of the subjects under study in this project were published and known and the importance of considering not only technical aspects but also the human part when deciding a solution was also transmitted to the students. Thanks to the diffusion of social networks and the website of the School of Engineering of Vitoria-Gasteiz, this EIP has contributed to making women's contributions visible in technological fields, a much needed work to increase the number of female engineers.

[2] for the subjects taught in Basque the guide "Euskararen Erabilera Inklusiboa" has been used

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References

1. Acker, S. (2000). Género y Educación: Reflexiones Sociológicas sobre mujeres, enseñanzas y feminismo. Madrid: Narcea.
2. Pérez Sedeño, E. (2003). La situación de la Mujeres en el sistema educativo de ciencia y tecnología en España y su contexto internacional. Madrid.
3. Arranz Lozano, F. (2004). Las muejres y la universidad española: estructuras de dominación y disposiciones feminizadas den el profesorado universitario. Política y Sociedad, 223-242.
4. Sagebiel, F., & Dahmen, J. (2006). Masculinities in organizational cultures in engineering education in Europe: results of the European Union project WomEng. European Journal of Engineering Education, 5-14.
5. Scott, J. W. (1996). El género: una categoría útil para el análisis histórico. En M. Lamas, El género: la construcción cultural de la diferencia sexual (págs. 265-302). Mexico: PUEG.
6. España. Ley Orgánica 4/2007, de 12 de abril, por la que se modifica la Ley Orgánica 6/2001, de 21 de diciembre, de Universidades, Boletín Oficial del Estado. Madrid, 13 abril 2007. Num 89, p.16242.
7. España. Ley 14/2011, de 1 de junio, de la Ciencia, la Tecnología y la Innovación, Boletín Oficial del Estado. Madrid, 2 de junio de 2011. Num 131, p. 8.
8. Buscatto, M., & Marry, C. (2009). « Le plafond de verre dans tous ses éclats ». La féminisation des professions supériurs au XXe siècle. Sociologuie du travail, 170-182.
9. Brawner, C. (2012). Women in Industrial Engineering: Stereotypes, Persistence annd perspectives. Journal of Engineering Education, 288-318.
10. Izquierdo, M. J. (2102). Justicia y calidad en las instituciones universitarias. En I. Perdomo, & A. Puy, Género, Conocimiento e Investigación (págs. 58-66). Madrid: Plaza y Valdes SL.

G-3

Promotion of scientific careers: the Aquí STEAM-UPC programme

S. Gómez[1], D. Ferrer-Balas[1], C. Fenoll[2], N. Garrido[2], G. Fargas[2]*

[1] Innovation and Community Bureau, UPC
[2] Executive Council, UPC
**vra.fargas@upc.edu*

Background

The "She Figures 2015" [1] European Commission report states that in 2012 the number of male and female PhD graduates was almost equal (between 40% and 60% of women). However, the number of men who intended to select STEM studies was almost twice as high as the number of women. The report confirms that low representation of women in science and engineering fields continues to be a problem. In 2012, women represented just 21% of PhD holders in computing in the EU-28.

The European Institute for Gender Equality (EIGE) provides some data in "Gender equality and digitalisation in the European Union" [2] (for 2017 and 2018) that reveal a high demand for digital professionals and a lack of women in STEM areas. According to the EIGE, the percentage of women who graduated in STEM in the EU dropped from 23% to 22% in the last decade. Participation of women in ICT is 14%. The EIGE considers that this gender segregation is one of the factors that contributes to the gender pay gap in the EU, as the ICT sector is one of the best paid. Within the ICT sector, the pay gap between men and women is lower (13%) than in other professional areas. The EIGE also indicates that women represent 17% of the 8 million ICT professionals in the EU.

The Spanish ministry report "Científicas en cifras, 2017" (Women scientists in figures, 2017) [3] states that horizontal gender segregation is still visible in the number of university students enrolled in bachelor's and first- and second-cycle degrees. In the 2016–2017 academic year, the percentage of female students of engineering and architecture dropped from 26% to 25%. In Catalonia, the Government of Catalonia's Women and Science Committee reveals in its statistical report that the percentage of female students of engineering and architecture (bachelor's, master's and first- and second-cycle degrees) was 24.57% in the 2016–2017 academic year.

The situation at the Universitat Politècnica de Catalunya (UPC) is like that of other technical universities in Spain and internationally. At the UPC in the 2006–2007 academic year, women on first- and second-cycle degrees comprised 24.40% of the total number of students. In the 2017–2018 academic year, women made up 25.00% of all new students. If we compare academic years 2012–2013 and 2017–2018 [4] (the first percentage in the brackets refers to 2012–2013 and the second to 2017–2018), the data on intake of women were respectively: bachelor's degrees (24.8%, 25.0%), master's degrees (33.2%, 35.0%), doctoral degrees (31.0%, 31.7%). However, when we focus on specific areas of knowledge, the situation varies. The proportion of all new students who were women in the 2017–2018 academic year in specific fields were: health sciences (optics and optometry) 71.8%, architecture 46.4%, industrial engineering 15.9%, informatics engineering 13.6% and naval engineering 15.9% (Table 1). The AQU 2017 report on graduate employment included informatics, industrial engineering and naval engineering among the top ten degrees, that is, degrees with the best professional prospects.

The gender gap in STEAM professions and studies indicates a lack of female talent and diversity in engineering solutions to society's needs, and a loss of social mobility opportunities as future STEAM professionals (women represent over 50% of the world's population). The complexity of these barriers goes beyond university boundaries and strategic partnerships are required with social stakeholders who influence this area.

Various sociocultural factors affect the academic degrees and technology careers that appeal to girls and boys when they choose their future studies and professions. These include stereotypes associated with technology and engineering and the existence of female and male roles rooted in family, school and social environments in general (family expectations, teaching methodology in primary schools, participation in classrooms, games and the media, among others), regardless of students' real academic results.

Table 1. Distribution of gender among new UPC students in the 2017–2018 academic year. (a) Bachelor's degrees, (b) master's degrees and (c) doctoral degrees

(a) New bachelor's degree students
UPC 2017–2018
by area of knowledge

Bachelor's degrees					
Field	2017_2018				
	Female	%Female	Male	%Male	Total
50% aerospace and 50% telecommunications	9	19.1	38	80.9	47
Architecture, urbanism and building construction	287	46.4	332	53.6	619
Applied sciences	33	33.0	67	67.0	100
Health sciences and technology	61	71.8	24	28.2	85
Aerospace engineering	61	23.7	196	76.3	257
Civil engineering	46	26.9	125	76.1	171
Biosystems engineering	73	44.0	93	56.0	166
Informatics engineering	71	13.6	452	86.4	523
Telecommunications engineering	105	19.4	435	80.6	540
Industrial engineering	438	20.1	1736	79.9	2174
Naval, marine and nautical engineering	23	15.9	122	84.1	145
TOTAL	1207	25.0	3620	75.0	4827

(b) New master's degree students
UPC 2017–2018
by area of knowledge

Master's degrees					
Field	2017_2018				
	Female	%Female	Male	%Male	Total
Others	30	33.7	59	66.3	89
Architecture, urbanism and building construction	196	50.9	189	49.1	385
Applied sciences	37	32.2	78	67.8	115
Health sciences and technology	23	85.2	4	14.8	27
Aerospace engineering	19	18.1	86	81.9	105
Civil engineering	76	30.2	176	69.8	252
Biosystems and agri-food engineering	7	58.3	5	41.7	12
Industrial engineering	161	21.1	602	78.9	763
Informatics engineering	29	22.7	99	77.3	128
Naval, marine and nautical engineering	2	4.9	39	95.1	41
Telecommunications engineering	19	14.5	112	85.5	131
Business management and organization	354	57.2	265	42.8	619
The environment, sustainability and natural resources	22	46.8	25	53.2	47
TOTAL	975	35.9	3620	64.1	2714

(c) New doctoral degree students
UPC 2017–2018
by area of knowledge

Doctoral degrees					
Field	2017_2018				
	Female	%Female	Male	%Male	Total
Architecture, urbanism and construction	28	48.3	30	51.7	58
Sciences	24	27.6	63	72.4	87
Civil engineering	29	31.2	64	68.8	93
Industrial engineering	61	38.4	98	61.6	159
TIC engineering	16	15.8	85	84.2	101
TOTAL	158	31.7	340	68.3	498

Development of the Aquí STEAM programme

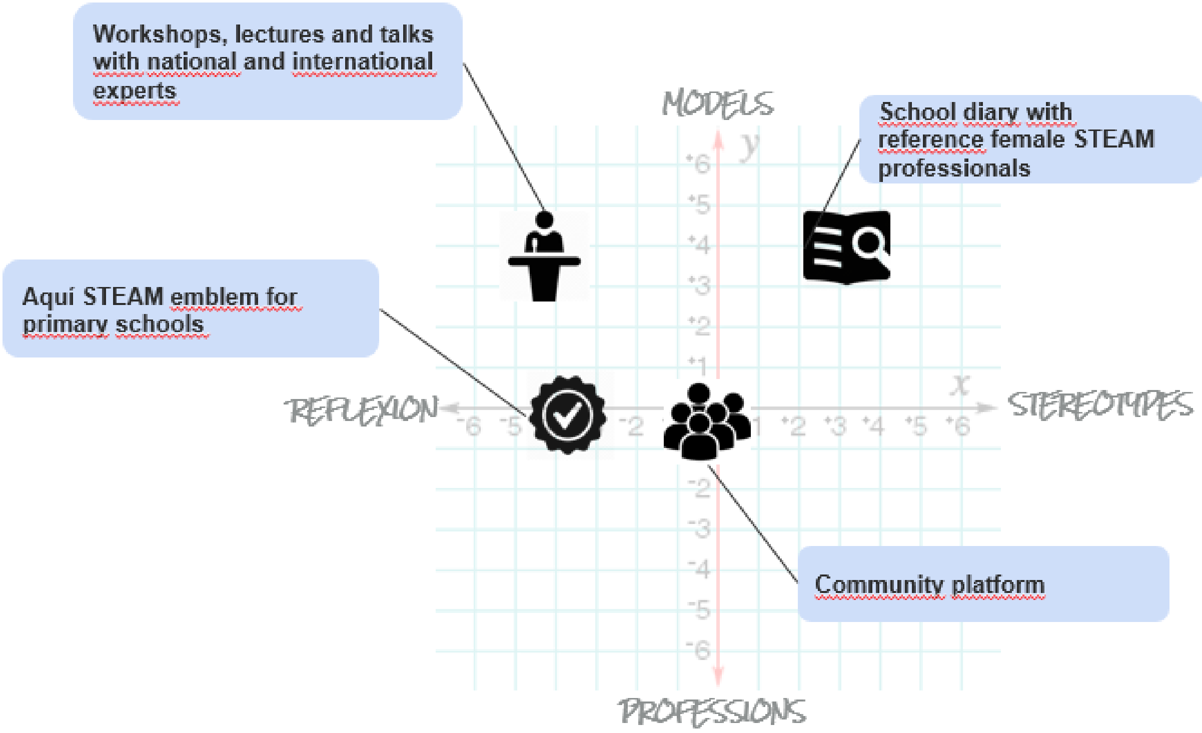
The UPC has been groundbreaking in the design of actions to attract talented young people to STEAM degrees. Notable examples are the UPC's DONA programme, which was implemented at the end of the 1990s until 2004 and focused on activities exclusively for girls, as well as the organisation of a summer campus with the same goal. As part of the second and third UPC equality plans (2016–2020), new projects have continued to be generated in recent years that are focused on promoting STEAM careers basically among young people who are in secondary school and upper secondary school education, with progressive interest and participation of schools. In the first phase of the third equality plan, the project +DonesTIC was developed, with the participation of the four schools that offer ICT-related qualifications at the UPC.

As a strategic area within its gender policies, the current commitment of the UPC is based on the Aquí STEAM programme to attract talent and raise the interest of girls who are in the upper cycle of primary school and the start of secondary school, in the age range of 9–14 years. Not only girls are targeted in the activities, but boys and girls together. Given that cultural change has to become in both genders: they will interact in the professional life and the goal is they do not perpetuate gender stereotypes. The programme was designed considering some of the main barriers to the incorporation of women in STEAM professions and studies, such as:

- The lack of female STEAM references and models.
- The existence of gender roles and stereotypes associated with engineering and ICT.
- The lack of knowledge of STEAM professionals and what they give back to society.

The programme is divided into four areas (Fig. 1.): models of reference, professions, stereotypes and reflection.

Figure 1. Strategic model of the Aquí STEAM programme



A set of actions have been planned that are designed to act directly on the elimination of these barriers.

- **"Aquí STEAM" emblem for schools**: the aim of this project is to provide tools for schools to bring STEAM studies into classrooms and include the gender perspective. A network of primary schools will be created that facilitates the exchange of experiences, good practices and concerns. There will be an initial 15-hour training programme (given by the UPC's Institute of Education Sciences and accredited by the Government of Catalonia's Ministry of Education), based on the principles of coeducation and on encouraging an interest in technology.
- **Workshops, lectures and talks**, among other resources: activities undertaken on request of schools that will enable girls and boys to experience STEAM professions first-hand and see the social applications of engineering. These actions are led by female STEAM professionals or researchers and help to break some of the stereotypes that dissociate engineering and technology from women.
- **Aquí STEAM school diary**: a project that, with the collaboration of other Catalan institutions, focuses on providing examples of female STEAM professionals in the classroom and knowledge of STEAM professions and studies for girls and boys, through a tool that is commonly used by students, that is, the school diary.
- **Cycle of reflection: "Mujer y tecnología, un tándem de futuro" (Women and technology, a tandem for the future)** (scientific supervision by the UPC, held in the Palau

Macaya of Obra Social La Caixa). Duration of the cycle: January 2019 to December 2019. The cycle examines the paradox of a world in which women are in the minority in engineering and technology, even though they make up over 50% of the world's population. This cycle reflects generally on the role that women play in technology and how we can bring about a richer, more diverse future with their full incorporation. The challenges that are set out are:

1. To share knowledge and initiatives to encourage girls to take technology degrees and women to advance professionally in technology environments.
2. To share local and international good practices.
3. To reflect on potential future strategies and propose activities in all areas of society.

The cycle is organised around two talks: an opening talk on ethics and engineering and a closing talk entitled "Gender quotas: from politics to business". Between these two talks are three thematic blocks (training block, employment block and society block). The blocks are divided into three specific workshops, with a round table to present the conclusions at the end of each block.

- **Aquí STEAM platform**: stakeholders, actions, resources and projects are coordinated in Aquí STEAM under the umbrella of a platform, an interactive community, so that Aquí STEAM becomes a network for exchanging the knowledge and practices of people and organisations who work to empower girls in their future careers. The platform is designed to create synergies and thus enhance the efficiency and impact of activities that are undertaken. The platform will promote interaction between new and existing programmes and initiatives, such as +NoiesTIC, the UPC mentoring programme M2m and "Una ingeniera en cada escuela" (A female engineer in every school), among others.

Conclusions

The fact that few women choose careers in the STEAM area is a great incentive to reconsider the type of relationship required between universities and society in order to change gender trends whose origin is markedly cultural. Increased awareness of the problem's complexity and the need for a multidimensional, network response to help change it have encouraged the UPC to establish a programme that is focused on generating a community of stakeholders and projects in a network, studying influences and exchanging knowledge to generate a joint proposal.

The Aquí STEAM programme, which started during the 2018–2019 academic year, has no quantitative results yet. The aim of this document is to share the qualitative approach.

References

1. European Comission, *She Figures 2015*, Directorate-General for Research and Innovation Directorate B – Open Innovation and Open Science Unit B.7 Science with and for Society, 2015.
2. European Institute for Gender Equality, *Gender equality and digitalisation in the European Union*, 2018 [https://eige.europa.eu/publications/gender-equality-and-digitalisation-european-union]

3. Ana Puy Rodríguez (coord). *Científicas en cifras 2017* Estadísticas e indicadores de la (des)igualdad de género en la formación y profesión científica, Ministerio de Ciencia, Innovación y Universidades, 2018 [http://www.ciencia.gob.es/stfls/MICINN/Ministerio/FICHEROS/UMYC/Cientificas_cifras_2017.pdf]

4. Planning, Assessment and Quality Bureau, UPC [https://gpaq.upc.edu/lldades/indicador.asp?index=genere]

5. Agència de Qualitat Unversitària. La insreció laboral dels graduats i graduades de les universitats catalanes, 2017 [http://www.aqu.cat/doc/doc_56174010_1.pdf]

G-4

Identifying the influence of students socio-economical status and life style on their academic performance using machine learning techniques

Lobo, A.[1], Moura, J.L.[2], Cuartas, M.[3]*, Torres, S.[4],
Sánchez, M.A.[5], Esteban-García, A.L[1]

[1] Department of Sciences and Techniques of Water and the Environment. School of Civil Engineering. University of Cantabria (Spain)
[2] Department of Transport and Technology of Projects and Processes. School of Civil Engineering. University of Cantabria (Spain)
[3] Department of Applied Mathematics and Computing Sciences. School of Civil Engineering. University of Cantabria (Spain)
[4] Department of Business Administration. School of Civil Engineering. University of Cantabria (Spain)
[5] Department of Sciences and Engineering of Soil and Materials. School of Civil Engineering. University of Cantabria (Spain)

e-mail corresponding Author: miguel.cuartas@unican.es presenting author: Miguel Cuartas

Introduction

Learning Analytics (defined as "the measurement, collection, analysis and reporting of data about learners and their context for purposes of understanding and optimizing learning and the environments in which it occurs") has proven to be helpful in Higher Education strategic areas such as resource allocation, student success, and finance [1]. One of the Learning Analytics techniques is machine learning, which has been successfully applied to predict students' performance based on their background and their in-term performance [2].

The objective of this research is to create a predictive tool for students' academic performance based on socio-economic and life style information. The general goals are to make available to students a tool to plan their time in a more efficient way and maximize their academic performance, to provide teachers with aggregate information about their students, allowing them to perform more effectively their teaching work and to offer the heads of the degrees and centres aggregate data on different subjects for a better design and management of curricula.

This contribution shows the preliminary results of the first phase of the project: a pilot trial to evaluate the viability of the concept. The result is aimed to be a scalable tool that will progressively incorporate more subjects and other degrees. At the same time, more data will allow to refine the predictive results.

Methodology

The study is based on conducting surveys to groups of students whose academic records are available anonymously. A numerical code allows relating the results of the surveys with the corresponding academic record.

In this first pilot test, a survey was prepared with the online tool Lime Survey (http://www.limesurvey.org/es/), which was answered by 12 first-year students of the Degree in Civil Engineering of the School of Civil Engineering of Santander (University of Cantabria). As an indicator of academic performance in this stage, the average score of the five courses they had studied at the time of the study was calculated.

The survey includes 90 questions about the origin and the family, the environment of the students, their previous academic career, study habits, leisure and daily organization, hobbies, satisfaction with studies, personal aspirations, health, character and emotional state.

In the preliminary analysis, the questions answered in a homogeneous manner by all the students were eliminated, such as: Do you smoke? (No); Do you have any disabilities? (No), Do you feel stressed by your studies? (Yes); Do you have a mobile phone? (Yes) and do you have data connection available in your mobile phone? (Yes).

The study conducted in this phase included 1) a descriptive analysis of the data by searching for linear correlations and graphic representations; 2) a selection and optimization of machine learning predictive models to calculate academic performance from data provided and 3) the identification of the fundamental variables in the prediction of student's performance.

For the development of the predictive models, the data were separated into two groups: one of 10 for training and validation of the models, and 2 for verification of the best models created.

Results and Discussion

Table 1 shows the variables that have the highest correlation with the student's average grade: a greater correlation is reflected with values closer to 1 or -1, depending on whether the relationship is direct or inverse. Thus, the more meticulous, methodical or planner the students consider themselves, the better is their average grade. Surprisingly, the more they declare to use other resources apart from class notes (books and other materials), the lower is their grade. One possible explanation for this is that the students with greater difficulties need these supports to a greater extent. It is also worth noting that students state that stress is the main cause of their bad academic results.

Table 1. Variables that have the highest linear correlation with average grade

Variable	Correlation factor
The student is meticulous	0.88
The student is methodical	0.83
The student is good at planning	0.61
The student is motivated with the studies	0.61
Expected years to complete the degree	–0.59
Stress negatively affects their studies	–0.71
Utilizes complementary material (e.g. books)	–0.75

Among the predictive models, the best result was obtained with the automatic learning technique Gradient Boosting [2], whose prediction capacity of the validation pair improved that of the equivalent linear regression model. A r^2 score of 0.96 was obtained in the training set and 0.91 in the validation set, with an optimized model of Gradient Boosting built with 200 estimators, learning rate of 0.01, maximum depth of 2 and minimum number of samples to split of 6. Table 2 shows the relative importance of the significant predictor variables identified by the model. The relative weights have been normalized so that the total sum of all the variables with weight greater than 0 is 1.

Table 2. Relative importance of the main variables identified by the Gradient Boosting model

Variable	Relative significance
Stress negatively affects their studies	0.270
The student is meticulous	0.237
Utilizes complementary material (e.g. books)	0.134
The student is good at planning	0.118
Average grade in high school	0.082
University entrance grade	0.042
Hours devoted to leisure	0.018
Married parents	0.018
The student is optimistic	0.013

In addition to some of the variables indicated by the linear regression method, some others appear with certain significance, such as the average grade in high school, the university entrance grade, the hours devoted to leisure, the fact that the parents are married or being optimistic.

Conclusion

Despite being based on a very small number of students, this pilot test has made possible to develop models that achieve a good predictive capacity of the students' average grade based on the information obtained from the designed questionnaires. The automatic learning techniques that have given the best results in this case are Gradient Boosting ($r^2 = 0.91$ in validation test) and, secondly, Linear Regression.

Thus, the designed methodology has proven its usefulness. It is proposed to advance in the research by applying the designed questionnaire to a wider group of students, so that more information is obtained and the conclusions shown here (or others) can be validated.

Based on the results like the ones obtained in this preliminary study, several measures can be proposed and designed to improve Higher Education learning, such as:

- To propose dynamics oriented to stress management.
- To implement training in organization and time management techniques.
- To guide the students in a correct use of study materials complementary to the class notes.
- To encourage adequate leisure and rest time.

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References

1. Leitner, P., Khalil, M., Ebner, M. *Learning Analytics: Fundaments, Applications, and Trends.* Peña-Ayala, A. (Ed). Springer International Publishing, 1-23, 2017.
2. Koutina, M., Kermanidis, *K.L. EANN/AIAI 2011, Part II, IFIP AICT*, 364, 159-168, 2011.
3. Friedman, J. H., *Annals of statistics*, 1189-1232, 2001.

G-5

Writing of stem women's biographies in Wikipedia format, an opportunity to improve Cross-curricular Competencies

Calvo-Iglesias, Encina[1]*, Lynch, Conor Douglas[2]

[1] Departamento de Física Aplicada, Facultade de Física, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

[2] Departamento de Filología Inglesa y Alemana, Facultade de Filoloxía Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

*encina.calvo@usc.es

ABSTRACT

The presence of women in careers and studies in the STEM fields (Science, Technology, Engineering and Mathematics) is very low. The reasons for this under-representation are diverse and include the scarcity of female role models in these disciplines. In this communication, we show an activity to provide female references to engineering students. The activity, developed in the degree in Chemical Engineering, consists of writing the biography of a STEM woman in Wikipedia format, and has been designed in such a way that it also serves to connect the subjects of Physics and Technical English. In addition, this task aims to improve cross-curricular competencies such as information management capacity, written communication in native and foreign languages and critical thinking.

The results of this task have been satisfactory. On the one hand, the students have increased their knowledge about female contributions to Physics and Chemical Engineering and, on the other hand, there has been an improvement in cross-curricular competencies.

Women in STEM

Spanish women are majority among university students, but they continue to be a minority in STEM careers (Science, Technology, Engineering and Mathematics). Despite the good professional prospects than STEM careers offer, women remain significantly underrepresented in these sectors (MICINN, 2018). This issue is becoming a growing concern due to the impact that the lack of diversity in the development of technologies may have in our daily life, or the inequality that this lack of presence may create in a highly technological society.

There are different reasons for this lack of interest, because girls are influenced by several social, cultural and economic factors, and the effect cannot be reduced to a single factor (Freire, Ruiz-Garcia & Oliver, 2018). Among the different reasons of this gender gap are the lower visibility of women working in STEM and the lack of female inspirational models. This gender gap is also in Wikipedia, where Google drives us when we do a search and where biographies about female scientists or engineers are scarce. Fortunately, there are projects like WikiProject Women Scientists that are changing this situation, or individual initiatives like the one promoted by physicist Jess Wade, who every day writes at least one Wikipedia page dedicated to a woman, a person of colour or an LGBTQ person in science in the hope of combating the lack of diversity (Wade & Zaringhalam, 2018).

Thus, we find that the students have little knowledge about the scientific or technological contributions of women. This knowledge, in many cases will not be increased after passing through the university, since there is a low level of mainstreaming of the gender perspective and scarcity of subjects in the undergraduate and postgraduate programs (Vergé & Cabruja, 2017). So, to make visible the contributions of women to science and technology, the students of first year of the Degree in Chemical Engineering of the University of Santiago de Compostela (USC) were asked to prepare the biography of a female scientist or technologist in Wikipedia and Galipedia format. This activity also serves to improve the skills of students since "the process of writing for Wikipedia covers all aspects of academic writing -originality, rigor, peer review, etc-" (Soler, Pavlovic & Font, 2018). Also, some of these biographies are only in English and this task is an opportunity to connect the subjects Physics and Technical English. This activity has been carried out through the virtual classroom of the subject in the platform Moodle, showing that the virtual classroom can be a place to improve equality.

Objectives

The main objective of this project is to recover the stories of women scientists and engineers and their innovations. Thus, we show examples of women (current and past) in science and technology to students. In this way, in addition to improving their skills and abilities, we are also contributing to the development of potential women editors of Wikipedia

Methodology

The project detailed in this report was carried out in the subjects of Physics and Technical English. These subjects are basic and compulsory and have an associated virtual classroom in Moodle, which is used as a content archive, with links to videos or articles of interest, as forums, also to increase student participation. In these subjects, we try to improve cross-curricular competencies such as written communication, critical thinking and information skills of students.

In first-year subjects, we often have students with little knowledge of inventions or scientific contributions (Calvo, 2017). To correct this, we have proposed the following task, figure 1, to increase the visibility of women scientists and engineers related to Physics and Chemical Engineering. The task, of a voluntary nature, was carried out through the virtual classroom of the physics subject, using the workshop tool of the Moodle platform.

Figure 1. Description of the task in the workshop of 2018

Description

The following task tries to make visible women (scientists, engineers and inventors) in Wikipedia. This activity consists in the accomplishment of the biography of a scientist, engineer in wiki format.

Group 1 (A- Fe) corresponds to Hertha Marks Ayrton's biography.

Group 2 (Fr-Lo) corresponds to Mary Sherman Morgan's biography

Group 3 (Lu-Q) corresponds to Donna Strickland's biography

Group 4 (R-Z) corresponds to Frances Hamilton Arnold´s biography.

For that, first, search the Wikipedia name of the scientist or engineer and see in which languages appear her biography. Next, a biography will be drawn up for Galipedia from those existing in other languages and also using the information that you read in books, such as *Mujeres en Ciencia y Tecnología* (Claramunt and Claramunt, 2012) or *Mujeres conciencia* blog.

The launch of the workshop Scientists and Technologists in Galipedia, includes the following steps:

- The teacher selects the biographies and creates the workshop.
- Students present their own work and then receive a proposal from another student to be evaluated according to the rubric (Calvo & Sanmarco, 2017). Two grades are given that appear in the Grading Book: a grade for the student's own presentation and a grade for the quality of their peer evaluation skills.
- The teacher reviews the grades and publishes the final grade. This assignment contributes 0.25 points to the final grade in this subject.

At the same time, in the subject Technical English for Chemical Engineers, the students were introduced to the biographies the aforementioned female scientists and chemical engineers. The task that the students were asked to complete involved translating the Wikipedia biographies of these inspirational female engineers from English to Galician, English to

Spanish, and Spanish/Galician to English, depending on the group each particular student was placed in, according to alphabetical order.

A class activity which really aided students' participation in this project, within the Technical English for chemical engineers in particular, was the undertaking of various listening exercises for example, Youtube videos relating to the lives of the women that the project focused on.

For the selection of the female scientists and engineers whose biographies the students are to prepare, different criteria have been taken into account, including the importance of their contributions in the scientific-technological field and the fact that the biography did not exist in the free encyclopaedia (in Galician or Spanish). Last year we gave priority to women inventors because for a long time, some of them have been forgotten and their inventions attributed to men (Calvo, 2018). This year, to celebrate that for the first time two scientists have won the Nobel Prize in Chemistry and Physics at the same time, we have proposed their biographies.

Results

The participation of students in this activity has been higher during the 2016-17 academic year, in which 72% of the enrolled students participated, 61 students (33 men and 28 women), while in the years 2017-18 and 2078-19 the number of students was respectively 43 students (25 men and 18 women) and 46 students (30 men and 16 women). Probably, the difference in participation is due to the fact that the exams were advanced until December, which has caused the students to devote themselves during this month to their preparation and abandon other tasks.

During the first two years the students have produced biographies of eight female inspirational models such as Fabiola Gianotti, Maria Telkes, Maria Teresa Toral, Mae Jemison, Maud Menten, Irmgard Flügge-Lotz, Lisa Jackson and Ellen Swallow Richards (Calvo and Sanmarco, 2017; Calvo, 2018). This year the students wrote the biography of Nobel Laureate in Chemistry Frances Arnold, Nobel Laureate in Physics Donna Strickland, rocket fuel scientist Mary Sherman Morgan, and suffragette, engineer, mathematician, physicist, and inventor Hertha Ayrton. In figure 2, we show two examples of the biographies made by the students.

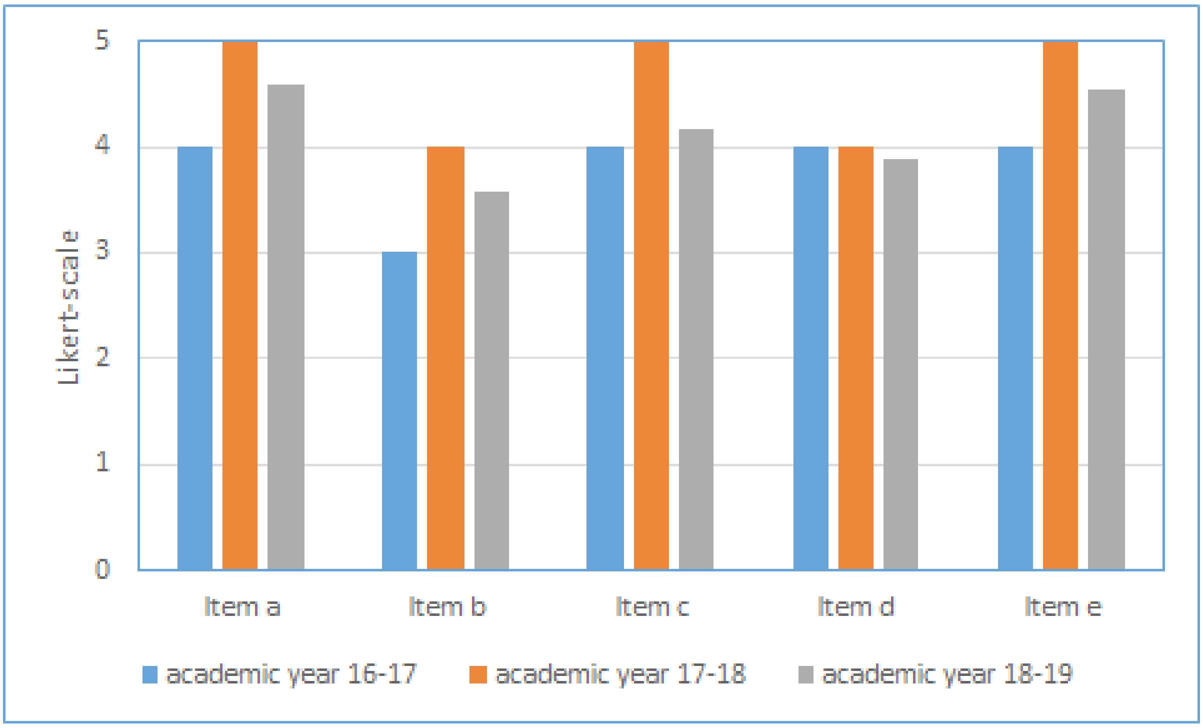
Figure 2. Examples of biographies elaborated by students

In order to know the opinion of the students about this activity we have used a simple questionnaire with five items of the Likert scale, where the range of the scale is 1= very disagree, 2= disagree, 3= somehow agree, 4= agree and 5= very agree. The five items were:

a. This activity helped me get to know women scientists related to Physics and Chemical Engineering.
b. This task helped me to improve my written communication.
c. I learned to write a biography in Wikipedia format.
d. I would like to publish the biography in Wikipedia.
e. I liked this activity.

Figure 3 shows the results of this survey in the three courses that were carried out. In view of the results, we can say that the activity is attractive to the students and that the objectives have been achieved, i. e., to provide female role models in science and engineering, and to familiarize the students with the Wikipedia edition.

Figure 3. Results of the student survey



Conclusions

The activity that we present in this communication has served to make visible women who have contributed with their inventions and contributions to the advancement of science and technology, as well as connecting two first-year subjects (Physics and Technical English) of the degree of Chemical Engineering.

This activity has allowed us to develop some of the cross-curricular competencies that appear in the didactic guides of both subjects such as communication in written language, information management capacity, comprehension of texts in English and critical thinking.

This task has been highly valued by the students, who consider that it has helped them get to know scientists and engineers, improve written communication and familiarise themselves with the Wikipedia or Galipedia edition. In future courses, we will continue with this activity because it contributes to creating an atmosphere of equality in the classroom.

References

1. Calvo, E. *First International Conference on Engineering Education for the XXI Century - ICEE21C 2017*, 2017.
2. Calvo, E. & Sanmarco, M.T. *Actas del III Congreso de Educación Mediática y Competencia Digital Mayo-Junio 2017*, 2553-58, 2017.
3. Calvo, E. *EDUcación con TECnología : un compromiso social. Aproximaciones desde la investigación y la innovación*, 1369-1374, 2018.
4. Freire, A., Ruiz-Garcia, A., & Oliver, V. M.. *ICGR 2018 International Conference on Gender Research,* 151- 160. 2018.
5. Ministerio de Ciencia, Innovación y Universidades. *Científicas en cifras 2017.* 2018.
6. Vergé, & Cabruja. *La perspectiva de gènere en docència i recerca a les universitats de la Xarxa Vives. Situació actual i reptes de future*. 2017.
7. Wade, J., & Zaringhalam, M. *Nature,* 2018.

S

Service-Learning and social commitment in engineering

S-1

Socially Committed Learning in Environmental Sustainability through 3D Digital Models and BIM

María Senderos Laka*, Iñigo Leon Cascante, Cristina Marieta Gorriti, José Javier Pérez Martínez

Engineering School of Gipuzkoa, University of the Basque Country, UPV/EHU
**maria.senderos@ehu.eus*

At the Engineering School of Gipuzkoa (ESG-EIG), Environmental Sustainability projects are being developed among students and professorate. Many of these projects are linked to the Sustainability Department Directorate of the Basque Country University (UPV/EHU). This allows a learning focused on service social commitment, where the boundaries of the classroom and the center are expanded to establish a direct relationship with the cities in which they are located. The environmental and socio-economic impacts of the university centers, of the UPV/EHU campuses and their influence in the cities that contain them, are being analyzed. Thanks to these analyses, energy improvement scenarios that enable an adaptation to the international regulations in this field for the years 2020-2030-2050, has been established. In order to carry out these analyzes, evaluation tools based on 3D information models are being used, which allow to introduce all the necessary data for the analysis of the current state (baseline scenario) and to be able to evaluate in an agile way the different improvement scenarios proposed.

The new digital technology, Building Information Modeling (BIM), will make it possible to manage these teaching centers, monitoring their environmental impacts throughout their whole Life Cycle. For this purpose, it is necessary to have 3D models of these centers, so that all the information necessary to obtain the impacts can be contained in them effectively, and can be evaluated efficiently. This permit to correct or redirect any impact that exceeds the parameters of Nearly Zero Energy Buildings (NZEB). To be able to perform a 3D modeling as accurate as possible of these centers, the massive capture of data is being tended, where techniques such as photogrammetry, and 3D scanning are a fact. In the ESG-EIG, the 3D building survey has been carried out using 3D laser scanners and RPA-s (Remotely Piloted Aircraft) to generate the point cloud that enables to obtain an efficient BIM model.

Sustainable planning of teaching facilities on an urban scale

Within the progressive scales of the so-called *Knowledge spaces* (Calvo-Sotelo, 2016), four levels of action can be distinguished: the first scale would be the urban-territorial relationship; the second, the university enclosure or campus; the third, the teaching building; and, finally, the classroom as the elementary spatial unit of the formative activity. Teaching methodologies begin to transcend the conventional boundaries of the classroom. The academic space is moving to new places, even outside the building or the campus, and can also reach the annexed city. In line with the theories of Aldo Rossi (Rossi, 1971), the space that surrounds the educational processes must maintain, since the initial ideas, a close relationship with the physical and social context, as the best guarantee for the development of the university mission. Non-formal or social learning involves the activation of alternative physical spaces in educational environments, characterized by responding to another formal nature and location different from the traditional one; thus, places such as leisure, communication, relationship, etc. areas would enter into action. The classroom begins to transform its limits into higher order spaces, dissolving into its closest environment: the building, the campus or the city.

Figure 1. Aerial photo of the San Sebastian campus, with the ESG-EIG building in the center of the image

Currently, there is a methodology for evaluating the energy and socioeconomic aspects of sustainable urban planning and rehabilitation where the university campuses are located.

Its objectives are the resources saving, the emissions and waste reduction, as well as the decrease of costs derived from the construction, conditioning and maintenance of urban areas in the management and planning of the existing city. This methodology has been created in a European Project called ESSAI URBAIN, coordinated by Nobatek (Technological Center, France), developed with Tecnalia Research & Innovation and with the City Council of San Sebastián (Oregi *et al.*, 2016). Based on different urban areas of San Sebastian, an environmental and social assessment software has been designed, integrated in the NEST program (Neighbourhood Evaluation for Sustainable Territories) created by Nobatek (Lotteau,Yepez-Salmon & Salmon, 2015). This allows the following actions in urban analysis: modeling the energy and environmental impact of neighborhoods using a real case study as a basis, promoting the use of Life Cycle Analysis (LCA) to make decisions related to the design or renovation of urban areas, and developing adaptable socioeconomic indicators within the NEST tool, capable of characterizing the neighborhoods. The NEST tool uses as a work basis a three-dimensional modeling of the studied urban area, to which the necessary data for the acquisition of the objectives are added. Therefore, it is a tool that will be able to be used under the BIM Technology.

Figure 2. 3D BIM model of the ESG-EIG

In the ESG-EIG of the UPV/EHU, different collaborative dynamics have been developed between students and professorate linked, above all, to Final Degree Projects, which focus on Environmental Sustainability. The University Campus of Donostia, among others, has been analyzed to compare it in terms of impacts with the results generated in the ESSAI URBAIN project. In this way, the effect of the campus on the city global emissions is evaluated, so that it has been possible to propose a reduction of these impacts, focusing on the saving of resources (Leon, Oregi & Marieta, 2018). These evaluations which have been carried out with the NEST tool are based on the LCA, where the inventory has a fundamental role, being the starting point for the evaluation. For this purpose, it is necessary that the centers collect data such as the use of resources (raw materials and energy), emissions to the atmosphere, soil and water, and the generation of waste.

The ESG-EIG, is committed to the environmental improvement plan, *Ekoscan* process, and records exhaustively all the necessary data to be able to obtain the impacts, although this dynamic is not usual in other university centers. In any case, these data are collected in Excel tables and written documents type .doc, which does not allow to relate the constructive or geometric characteristics (surface of facades) with the evaluation. That is why the BIM 3D Models allow a more accurate assessment of emissions, facilitate the presentation of more concrete and effective technical solutions, and help reduce the costs of executing energy improvement solutions.

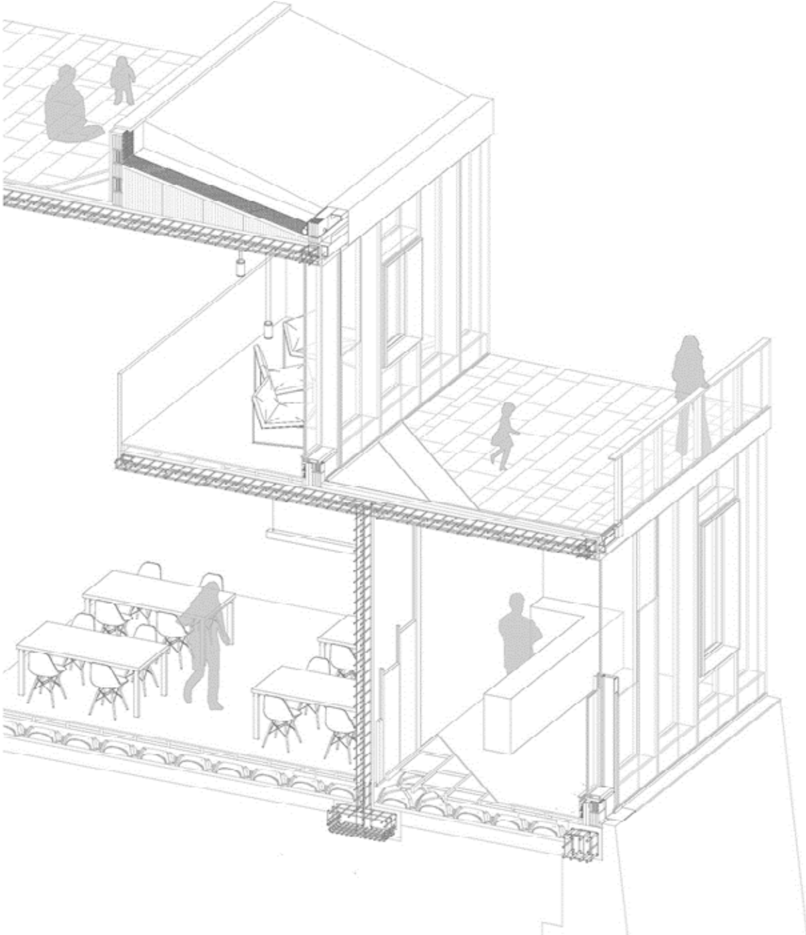
BIM models for sustainable teaching management

On July 14, 2015, the Ministry of Public Works constituted the Commission for the implementation of the BIM methodology in Spain. The marked milestones established two crucial dates: December 17, 2018, for the mandatory use of BIM in Public Tenders for Building Works, and on July 26, 2019 in Public Infrastructure works. It should not be forgotten that this technology requires a revolution in thinking and in the way to operate in academic activities (Monteiro, 2012). So that, the Degrees of Building Engineering (Technical Architecture) and Civil Engineering of the EIG, are already involved in the training of multiple engineering students to adapt to these requirements that will impact society, to transform the construction industry in infinitely more sustainable processes (Sacks & Barak, 2009).

The BIM methodology is a technological tool for the management of projects, through a unique three-dimensional digital Model of Information (Agustín, 2011), which reduces costs, shortens design and production times, improving the quality of construction projects. In addition, it allows students to improve their learning so that they are able to adapt to continuous changes and can respond creatively, promoting critical thinking through synchronized collaborative methodologies in the network.

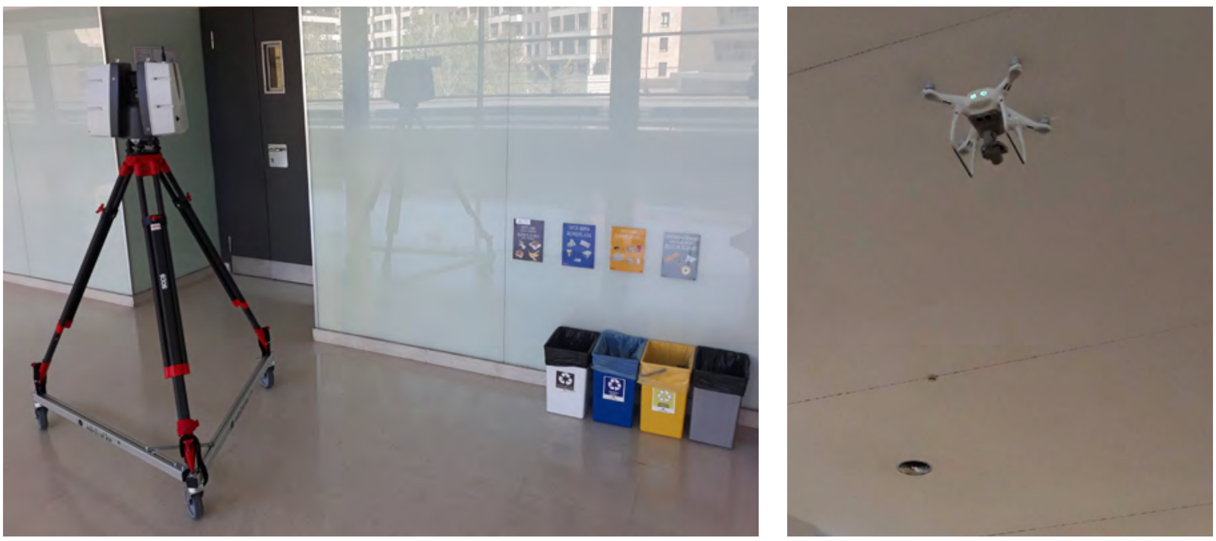
BIM covers the entire Life Cycle of the building, is applicable both for the monitoring of certain parameters necessary in the analysis for sustainable planning, in the management and maintenance of the teaching buildings, and for the reform or modification of spaces. The teaching building BIM 3D model can include parameters and data of all kinds (schedules of occupation of spaces and classrooms, number of students in each class, consumption, production of waste from the center, etc.). In order to perform these tasks, it is necessary to manage the *As Built* model of the building, which is the three-dimensional model of the building as it has been built, which implies a very precise data collection task. To achieve this model with precision in an efficient way, compared to traditional techniques, mass capture techniques are being used by means of photogrammetry and laser scanning. Recently, the ESG-EIG has resorted to the cloud-to-cloud 3D scan of the building through Leyca's P40 scanner, and low-cost photogrammetric techniques through of the DJI Phantom 4 pro drone (RPA).

Figure 3. *As built* model of educational center



Source: Aimar Santos

Figure 4. Mass capture of the ESG-EIG building, 3D scanning and RPAs



This will not only allow a reduction of the environmental impacts of the center due to predictive maintenance and effective management, but also a learning focused on the service of social commitment, linked to the city, transcending the limits of university institutions.

References

1. Agustín, L., Hacia el proyecto digital. En: *EGA. Revista de Expresión Gráfica Arquitectónica*, 18, 270-279, 2011. DOI:http://dx.doi.org/10.4995/ega.2011.1112
2. Calvo-Sotelo, P.C. & Márquez, F., Memoria e innovación en los espacios físicos de enseñanza/aprendizaje de la educación superior. La transformación del límite como respuesta de la Arquitectura a la innovación docente. En: *Historia y Memoria de la Educación*, 3, 279-320, 2016.
3. Leon, I., Oregi, X, & Marieta, C., Environmental assessment of four Basque University campuses using the NEST tool. *Sustainable Cities and Society*, 42, 396-406, 2018. DOI: 10.1016/j.scs.2018.08.007
4. Lotteau, M., Yepez-Salmon, G. & Salmon N., Environmental assessment of sustainable neighborhood projects through NEST, a decision support tool for early stage urban planning. Symposium "Towards integrated modelling of urban systems", *Procedia Engineering*, 115, 69-76, 2015. DOI: 10.1016/j.proeng.2015.07.356
5. Monteiro, A., *et al.*, O BIM e o ensino de projeto de edificações nos cursos de Arquitetura e Engenharia Civil em Minas Gerais: *Proceedings of the 16th Iberoamerican Congress of Digital Graphics*. Fortaleza, Brasil, 575-579, 2012.
6. Oregi, X., *et al.*, Sustainability assessment of three districts in the city of Donostia through the NEST simulation tool. *Natural Resources Forum*. 1-13, 2016. DOI: 10.1111/1477-8947.12104
7. Rossi, A., *La Arquitectura de la Ciudad.* Barcelona: Editorial Gustavo Gili, 1971.
8. Sacks, R.; Barak, R. Teaching Building Information Modeling as an integral part of freshman year civil engineering education. *Journal of professional issues in engineering education and practice*, 136 (1), 30-38, 2009.

S-2

Design and Disability: A Service-Learning Experience for Second Course Undergraduates

Raúl Izquierdo[1]**, Luis Cabedo[1], Marta Royo[2]*, Mar Carlos[2], Vicente Aparici[1], Raquel Oliver[1], José Ortega[1], Adolfo Reina[1]

[1] Departament d'Enginyeria de Sistemes Industrials i Disseny. Universitat Jaume I
[2] Departament d'Enginyeria Mecànica i Construcció. Universitat Jaume I
Corresponding author: royo@uji.es
Presenting author: rizquierdo@uji.es

Nowadays, the changes in the information and communication society, the social networks, a neoliberal economic model and the delocalization and decentralization of knowledge have led to a questioning on the role of the universities as its creators and transmitters [1]. According to Castells [2], the University has the task of adapting to these changes, so the implementation of novel learning methodologies can be helpful in order to achieve that purpose.

Therefore, these methodologies have to take into account three main aspects. Firstly, formal environments are no longer primary sources of knowledge, which means learning can be carried out in non-formal and casual settings. Secondly, knowledge is multiple and uncertain, so the acquisition of abilities for discerning which one is the valid, useful and productive information is important. Finally, learning is a continuous process, so training and education ought not to be detached from the working career [3].

Apart from these considerations, the suppositions made by Delors [4] in his report have to be followed; not only about learning to learn, but about learning to do, learning to be and learning to live together [5]. This holistic and integrated vision of education pursues the formation of able citizens, capable of adapting to the current changing, complex and inconstant social context.

All these ingredients, cooperation, peer-learning and abilities such as the selection or the analysis of the information can only be achieved by the democratization of the teaching-learning process and the application of methodologies that enhance the activity and participation of students who are, indeed, the true protagonists.

The aim is not the formation of not only qualified technical specialists but also professionals who are competent and committed to their surroundings [6]. Civic responsibility and social commitment are thus considered as values to be linked to their professional careers; therefore these abilities have to be trained during their educative period, as a highlight amongst the tasks higher education has to fulfil [7]. University social responsibility seeks for the public good and advocates a more fair and democratic society, and directs the educational model and the teaching activity towards this direction [8].

One of the methods that allow training the university social responsibility in higher education is Service-learning; a learning method based on an experience that arises from a social request [9]. The Chilean Education Ministry [10] states that Service-learning results in community service pedagogical projects that are integrated in the curriculum. By means of these projects, students apply, verify and go more deeply into their knowledge, as well as the provide solutions to community problem; so they discover, apply and fathom out the concepts of their discipline and their relationship with real situations and the solving of concrete problems.

Service-learning methodology works with groups of students who face up to community problems, seeking for and thinking over real objectives thus boosting their own comprehension and skills, and developing multiple human dimensions while they cultivate civic and social responsibilities [11].

This communication would show the experience of applying a Service-learning methodology, in a coordinated manner between two subjects of the second course of the degree of Industrial Design and Product Development Engineering of Universitat Jaume I at Castellón de la Plana. In this experience, students have worked throughout the whole academic year in designing a product which has been promoted by a collective of dependent people; concretely, the users of the Aspropace Foundation in Castellón. Foundation users are adults with cerebral paralysis and related encephalopathies. The product to be developed was an innovative soap cutter for them capable of improving the existing ones. This product will take into account two issues: that anyone can use it and that the less force is used for its use. This experience has been carried out during the two terms of the academic year 2018/19 in a coordinated manner between teachers and students of two different subjects (Conceptual Design and Materials II), jointly with the technical staff of the Aspropace Foundation and the final users.

Diverse activities were programmed temporally for correctly applying this methodology. During the first semester, there were various meetings between promoters and professors and the visit of students to the Foundation center (Figure 1), which ended in the realization of several conceptual proposals of the product (Figure 2). In the second semester, the ideas were developed and studied in terms of usage and materials, and prototypes were materialized in workrooms. Finally the prototypes were presented and handed out to promoters and users (Figure 3).

The complexity of this experience lies in various aspects:

- The horizontal coordination between subjects which are radically different both in field of knowledge and typology. The first one (Conceptual Design), in the first semester, where students generate ideas by using diverse methodologies, which are finally sketched, and the second one (Materials II), in the second semester, where they

materialize and develop a real prototype of their final idea while they study the functional problems that might arise from the selection and usage of materials.
- The development of a whole project that would help students acquiring a complete vision of the engineering and design processes, in the first years of the degree (in the second year).
- The establishment of non-academic relationships with real promoters, users and involved centres, whose presence have invigorated the project, while provides it with a professionalizing atmosphere, similar to the ones students might find once incorporated to the labour market.
- The extension of the students' reflection, vision and execution of a design project, thus exceeding its merely academic nature and enhancing the University social responsibility.

The assessment of the experience in terms of its impact is to be carried out by means of the analysis of the impressions of the stakeholders (teaching staff, students, technicians, final users and practitioners). To do so, various surveys and interviews have been developed in order to obtain results, both qualitative and quantitative, which improve the comprehension on what this experience meant for all the interest groups.

The final aim of the article is the assessment of the repercussion of this methodological change on the motivation and implication of the involved students and teaching staff, as well as obtaining information on their ability and its improvement for adapting to the novel situation and needs that were required throughout this project.

Figure 1. Meeting between promoters, users, professors and students

Figure 2. Different examples of soap cutter projects

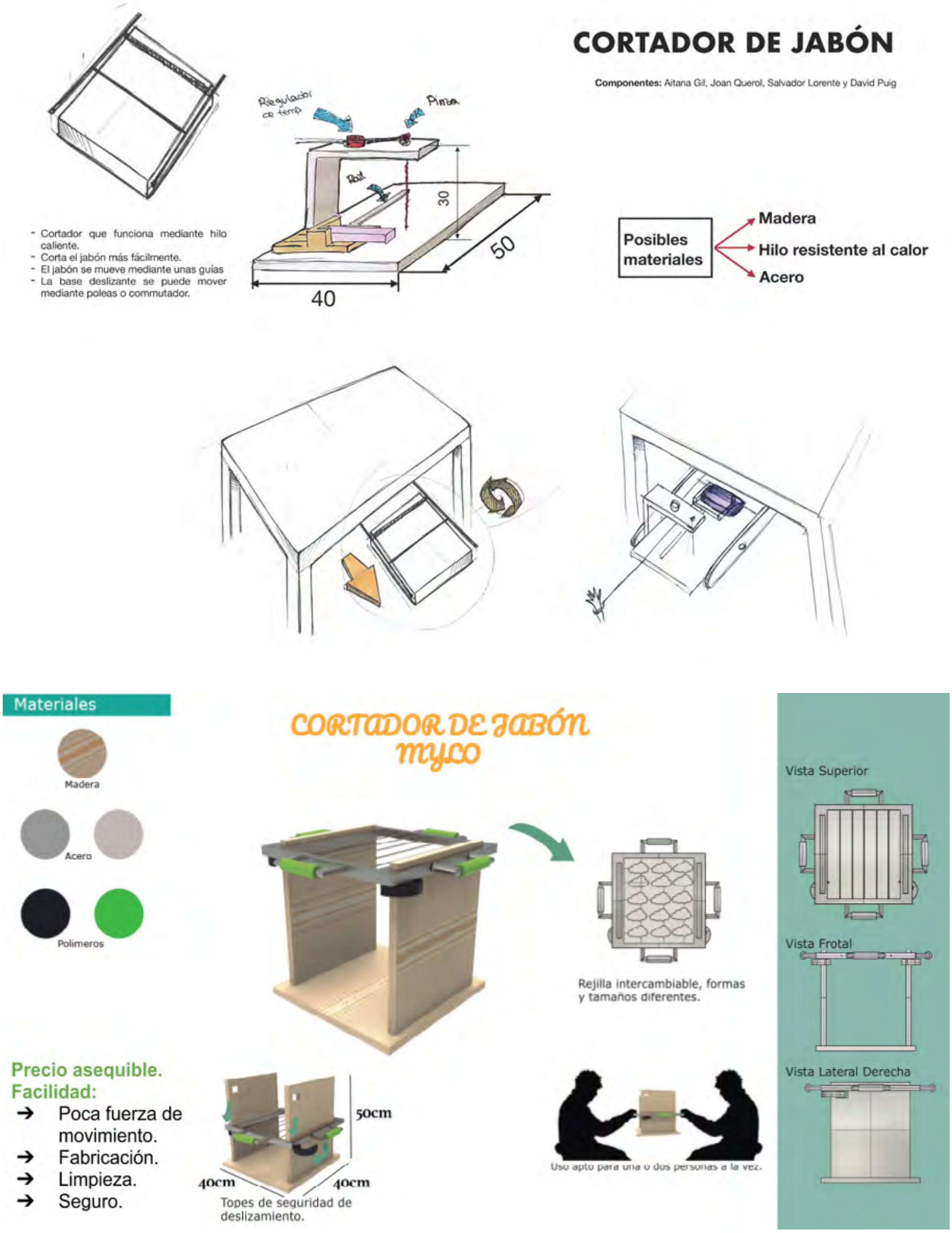
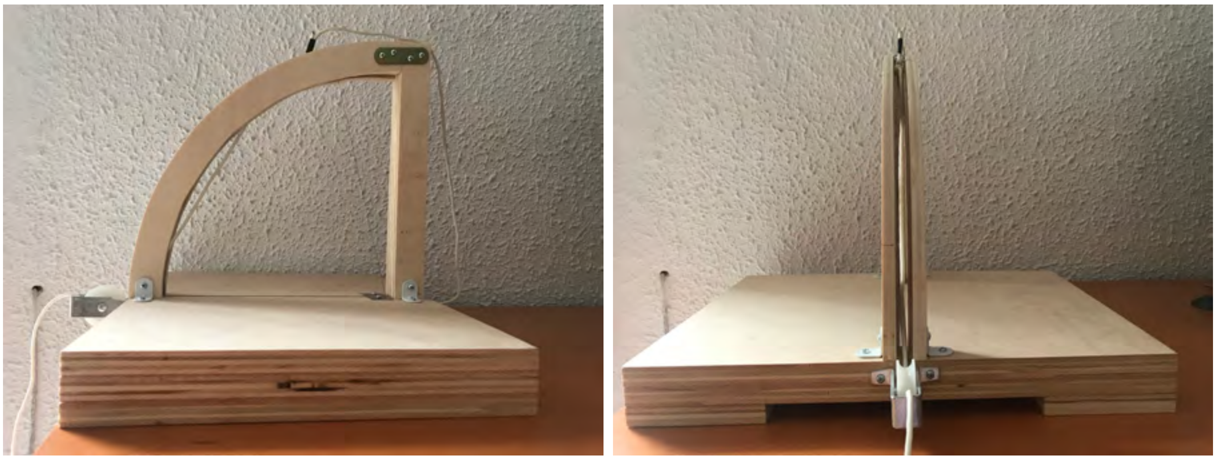


Figure 3. Final prototypes



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References

1. Cabedo, L., Gámez-Pérez, J., Segarra, M., López-Crespo, P., Izquierdo, R., Royo, M., Moliner L., and Guraya, T. *La metodología de aprendizaje basado en proyectos (ABP) aplicada a asignaturas de ciencia de los materiales en ingeniería en la red IdM@ti*, Material-ES, 1(2) , 25-28, 2017.
2. Castells, M. La era de la información. *Economía, sociedad y cultura*, México: Siglo XXI, 1, 1996.
3. Pozo, J.I. La nueva cultura del aprendizaje en la sociedad del conocimiento. En J.I Pozo; N. Scheuer; M. del P. Pérez; M. Mateos; E. Martín y M. de la Cruz. *Nuevas formas de pensar la enseñanza y el aprendizaje*. Barcelona, Graó, 2006.
4. Delors, J. Informe Delors. *La educación encierra un tesoro*, Madrid: UNESCO. Santillana. 1996
5. Caspi, A., Gorsky, P., and Privman, M. Viewing comprehension: Students' learning preferences and strategies when studying from video. *Instructional Science*, 33(1), 31-47, 2005.
6. Cabedo, L., Giménez, I., Royo, M., Lapeña, L., Beltran, H., Cabedo A., and Hernández, L, El aprendizaje servicio como oportunidad para introducir competencias de RSU en los grados de ingeniería. En Andrés, A., Barberá, S., & D. Pallarés (Eds.), *Nuevas perspectivas en la gestión de la responsabilidad social en las universidades*. Colección "Humanitats" N° 53. Publicacions de la Universitat Jaume I, Castelló de la Plana, 2017.
7. V. González, La formación de competencias profesionales en la universidad. Reflexiones y experiencias desde una perspectiva educativa, Revista de Educación, 8, 75-187, 2006.
8. Martínez, M. Aprendizaje servicio y construcción de ciudadanía activa en la universidad: la dimensión social y cívica de los aprendizajes académicos, en Martínez, M. (ed.): *Aprendizaje servicio y responsabilidad social de las universidades*, Barcelona, Octaedro, 11-26, 2010.

9. Eyler J., and Gilers, D.E. *Where's the learning in service-learning?* San Francisco, Jossey-Bass, 1999.

10. Chile, Ministerio de Educación . *Manual de Aprendizaje Servicio*. Mineduc. 2007

11. Royo, M., Cabedo, L., Carlos, M., Chulvi V., and Ruiz, L. *Aplicación de la metodología basada en aprendizaje-servicio para la generación de nuevos conceptos de producto*, AEIPRO 2018

S-3

Reconditioned Laboratory Furnaces by Materials Engineering Students

J.A. Padilla, A. Calderón, A. Svobodova, M. Martínez, M. Segarra*

Consolidated Group in Educational Innovation Structure, properties and processing of materials (GIDC e-ppm), Department of Materials Science and Physical Chemistry,
Universitat de Barcelona, Martí i Franquès, 1, 08028-Barcelona (Spain)
m.segarra@ub.edu

Usually, engagement of students into laboratory practices becomes an important challenge to overcome, especially when talking about technological subjects, where expensive or big apparatus should be used and lack of time or facilities for students to put into practice the knowledge acquired in the classroom make it unaffordable. In the degree of Materials Engineering at the University of Barcelona many subjects have a practical nature that is often supplemented with complementary teaching material such as videos. This is the case of the subject of Industrial Technology. In it, knowledge of electrical engineering is taught, and includes a few topics dedicated to the different types of furnaces used both at the laboratory and industrial level. This subject consists of a practical part, but until now the students were walked by the research laboratories so that they could see how muffle or induction furnaces work, for example, but without even touching them. On the other hand, the laboratory furnaces used in the laboratory teaching practices of the different grades in which the departmental section of Science and Materials Engineering participates, tend to have a shorter lifespan than expected, often deteriorate due to the failure of the electrical resistances, or the occasional pouring of molten materials inside. This course we have implemented laboratory practices for Industrial Technology subject in which students have to repair a muffle furnace used in the laboratory practices. The idea is to put into practice the knowledge acquired in the classroom and learn to repair a furnace by doing it themselves. The students have different refractory materials, insulators and for electrical resistances of which they should choose the most suitable for the reconstruction of the furnace. For this, they will use CES Edupack as a tool for their selection. In this work the activities carried out are related as well as the degree of satisfaction of the students once these practices are carried out, which can be classified as service-learning.

Keywords: service-learning; project-based learning; laboratory practices.

Introduction

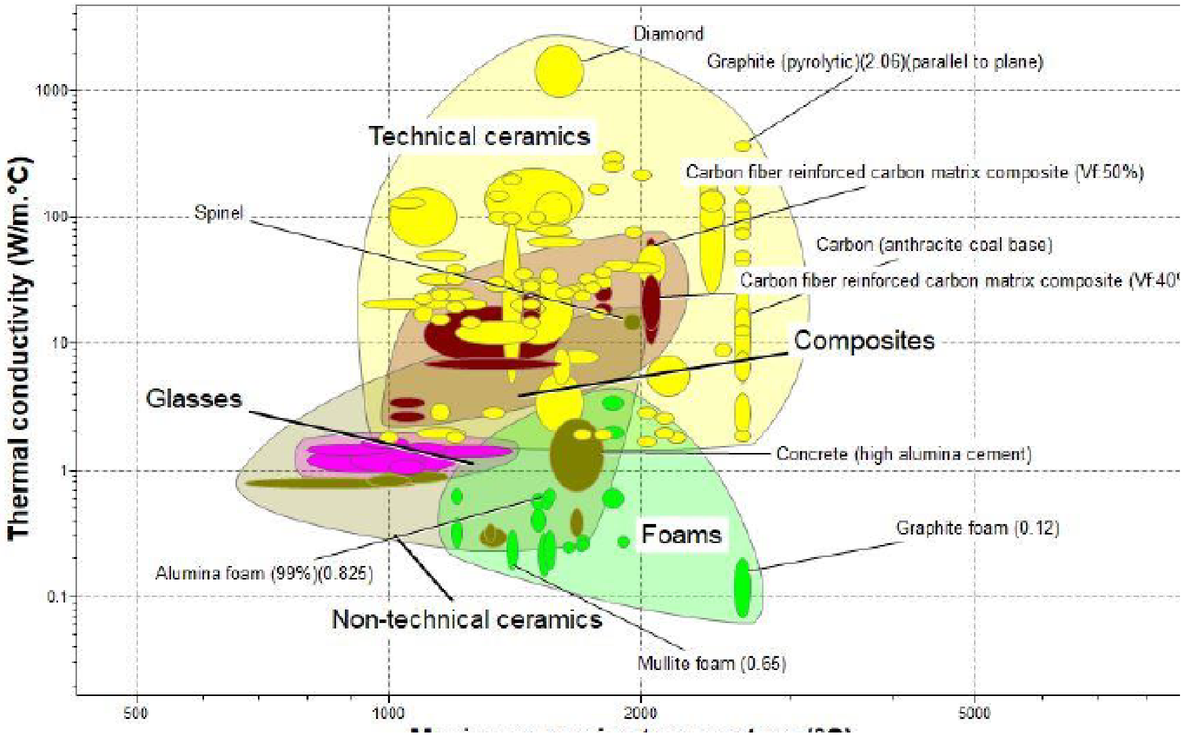
The subject Industrial Technology in the Materials Engineering degree at University of Barcelona is divided into two blocks: the first one devoted to the basis of electrical engineering (two thirds of the subject) and the second (the remaining third) to the explanation of the different types of furnaces that can be found both at laboratory and industrial scale. This subject (6 ECTS) is in the 7th semester of the degree and has 12 hours of laboratory practices, until now proportionally distributed between both blocks of theory. Up to this course only 4 hours could be used for practicing the furnaces block at lab. So, the students could only walk by the research laboratories so that they could see how muffle or induction furnaces work, for example, but without even touching them.

On the other hand, the laboratory furnaces used in the laboratory teaching practices of the different grades in which the departmental section of Science and Materials Engineering participates, tend to have a shorter lifespan than expected, often deteriorate due to the failure of the electrical resistances, or the occasional pouring of molten materials inside. This implies an investment in new furnaces which, unfortunately, is not available.

This course 9 hours have been assigned to the second block of laboratory practices for Industrial Technology subject, so a new type of laboratory practices has been designed. We have developed and implemented a new labwork in which students must repair a muffle furnace previously used by their pairs in the laboratory practices. The possibility of contributing with their work to the improvement of facilities used by the same students or by their pairs, could be classified as service-learning The final aim of the lab practices is to put into practice the knowledge acquired in the classroom and learn how to repair a furnace by doing it themselves.

The students have different refractory materials, insulators and for electrical resistances of which they should choose the most suitable for the reconstruction of the furnace. First, they use CES Edupack as a tool for the selection of the most appropriate material for refractory walls (Figure 1), insulation walls and electrical resistances, applying the knowledge acquired in the theory classes. Then, they must return to reality and effectively select the best material from those available in the laboratory.

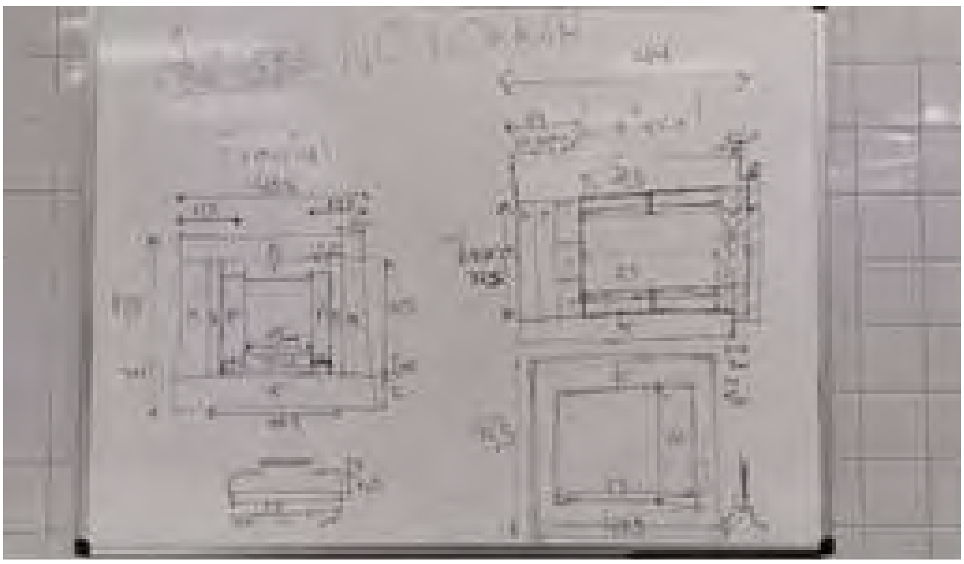
Figure 1. CES Edupack software is used for refractory and isolation materials selection. Chart from CES EduPack 2018, Granta Design Limited, Cambridge, UK, 2018 [1]



Measures, calculation and rebuilding

Before starting to rebuild the furnace, students measure the furnace casing and calculate the thickness of the refractory and isolation walls using the knowledge acquired in theoretical classes (Figure 2).

Figure 2. Students measure the furnace casing and make the calculations

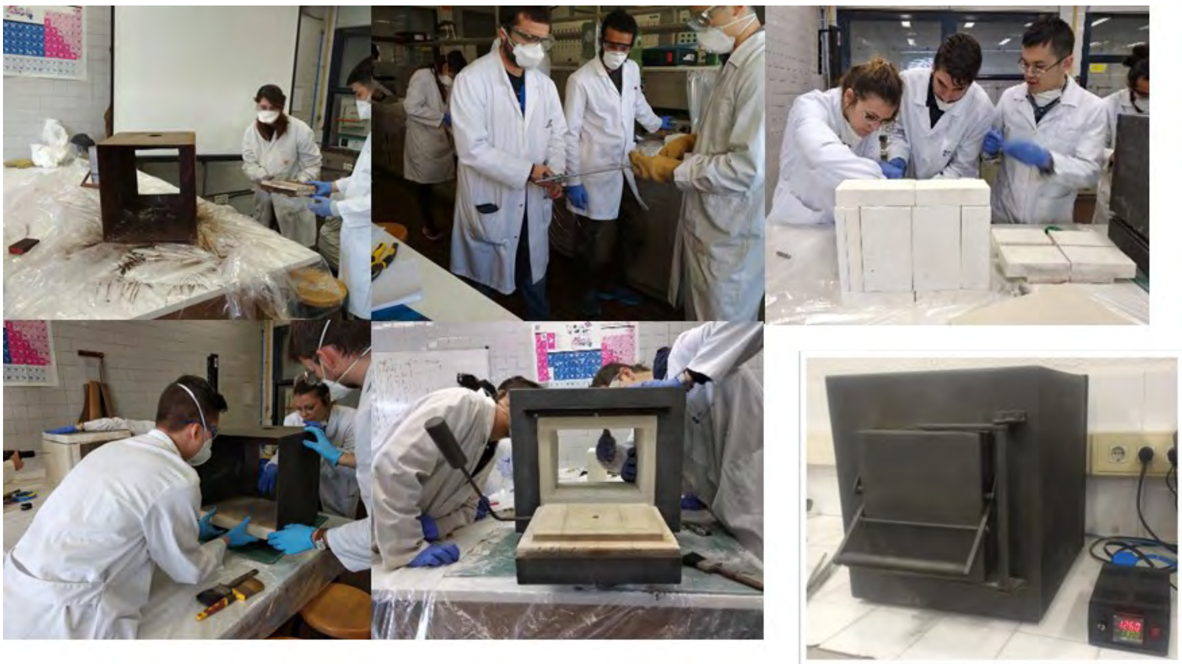


They must consider the specifications of the materials (Figure 3) that will be provided to them to minimize the thermal transfer through the walls. On the other hand, they must calculate the length, measure, cut and wind the Khantal^{R} wire to make the electrical resistance.

Figure 3. All the needed materials and tools are provided

With the help of the lecturers, old furnace casing is emptied, refractory and isolation blocks are cut, and electrical resistances are wound. Further, they rebuild completely the furnace, also connecting the control system (Figure 4).

Figure 4. Different stages of the reconstruction process and final furnace ready for being calibrated



Once the furnace is completed, it is plugged and started to be heated to burn the isolation boards and cement used to make the walls.

Calibration

Finally, the temperature is recorded and compared with the set-point to determine the difference between them. An infrared camera is also used to detect the possible thermal loses of the furnace (Figure 5).

Figure 5. To calibrate the furnace, a temperature probe is used (left). An infrared thermal camera shows the thermal loses due to poor insulation (right)

Results and discussion

At the end of the laboratory practices a survey was performed in order to grasp the opinion of students and lecturers. All the students agree on that this new type of labs provide knowledge and involvement, encourage creativity, initiative, and teamwork although they do not promote their autonomous work. Finally, they consider that are fully complementary to theory and a good approach to professional life. On the other hand, lecturers completely agree with the perceptions of students, but they add that the time devoted to these labs is not enough for students to complete the work alone.

Conclusions

Both students and lecturers have expressed their huge degree of satisfaction with the performed work. Students all agree with these practices, considering that they are one of the most productive and profitable of the degree. They think that are also the best lab practices ever made, and that this format increases interest in the subject.

On the other hand, lecturers suggest that the time involved in preparing and developing the work should be longer (9 hours is too tight).

References

1. CES EduPack software, Granta Design Limited, Cambridge, UK, 2018 (www.grantadesign.com).

S-4

Results of the Institutionalization of Service Learning at Universitat Rovira i Virgili: Implementation in Engineering Studies

Avril Lombardi Bolaño*, Maria Marquès i Banqué, Sandra Contreras Iglesias, Dolors Setó Pàmies, Fàbia Morales Vives

Universitat Rovira i Virgili (URV)
avrilcecilia.lombardi@urv.cat

Introduction

Service Learning (SL) is an educational proposal that combines learning processes and community service in a single project, in which participants learn while working on real needs and trying to improve their environment. SL has a solid institutional framework at Universitat Rovira i Virgili (URV); where it has been integrated into several strategic plans, academic normative and it also has a specific action plan, approved by the Governing Council in 2012 and updated in 2015. SL is an instrument of integral university training in which the principal objective is to train socially responsible professionals.

In the 7 years that it has been running, the SLP has become highly institutionalized at the URV and is an initiative that innovatively links the university's three missions through projects based on the real needs of society and implemented by students and professors of the URV and community stakeholders. The process of institutionalizing the SLP at the URV over the last seven years has led to several achievements, in particular the presence of SLP projects at 11 of our 12 faculties and schools and in all areas of knowledge at the university, including social and legal sciences, health sciences, arts and humanities, engineering, architecture and sciences.

Results and Discussion

Since the 2012-13 academic year, students at the Universitat Rovira i Virgili (URV) have been able to sign up for the Service Learning Programme (SLP) and do part of their courses by undertaking activities aimed at making a positive contribution to society, culture and the environment.

At the URV, the SLP is governed by a legal and institutional framework, which defines it as an instrument for University Social Responsibility (USR). In this regard, it forms part of the URV's project to develop and implement a new model of transversal competences that enable the university to evaluate students' acquisition of the CT7 competency: Apply the ethical principles of social responsibility as a citizen and as a professional. In this way, the university aims to help foster the values of social responsibility and social commitment in the citizens of the future.

The SLP is integrated into various strategies and academic plans and has a specific action plan that was approved by the URV's Governing Council in February 2012 and updated in 2015. It is specifically included in the Strategic Plan for the Third Mission, approved in 2009, as an action associated with the objectives of axis 2 (society, service learning, volunteering and cooperation in development) and in the Strategic Internationalization Plan, approved in November 2013. In its broadest sense, the third mission deals with the transfer of knowledge to society and, in particular, focuses on the social aspects relating to public service that are upheld by all higher education institutions. The SLP is also included in the Strategic Teaching Plans and the Strategic Plan of the Social Council of the URV through the support offered by the URV's Social Projects Market.

SLP experiences have formed part of 48 different programmes and more than 148 different courses. During this period, more than 201 teaching staff have been involved in the SLP and around 351 non-profit entities have benefited from services provided by students. Service Learning has included all kinds of local and international organizations such as town and city councils, public bodies, neighborhood associations, citizen platforms, and social, cultural and environmental federations, foundations and associations (link to the map of collaboration organizations: http://www.urv.cat/es/estudios/modelo-docente/aprendizaje-servicio/mapa-entidades/).

Data from the 2017-18 academic year show that more than 900 students participated in the programme, a significant increase since the year when it was first implemented. Once students have completed the SLP project, they complete an online satisfaction survey that gathers important information on the procedures followed, the activities carried out, the roles of the academic tutor and the professional individuals at the participating organization, and the student's general evaluation of the SLP experience.

In terms of quantifying the economic impact of the students' SLP activities, it is important to emphasize that from the 2011-12 to the 2017-18 academic years, URV students completed a total of 433,653 hours of service to the community, valued at 1,802,847 euros (estimated value calculated on the basis of the minimum wage).

Service Learning Programme Outcomes

Table 1. Service Learning Programme outcomes per academic year

Academic year	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
Courses with SL component	13	28	49	76	76	77	82
Projects	14	38	56	82	94	83	97
Programmes	10	17	26	33	28	26	24
Undergraduate	8	13	20	27	24	20	19
Graduate	2	4	6	6	4	6	5
Students	181	265	477	769	833	799	906
Faculty	23	40	85	93	97	93	90
Community organizations	31	31	90	118	141	150	136
Students social action hours	2.675	30.247	53.445	80.693	86.815	86.887	92.890

Table 2. Service Learning Programme accumulative outcomes

Courses with SL component	148
Projects	464
Programmes	48
Students	+700 per academic year
Faculty	201
Community organizations	351
Students social action hours	433.653

SL experiences has also had an important presence in School of Engineering, with Final Projects and different courses with SL component.

Service Learning Programme Engineering Projects

Table 3. Service Learning Programme Engineering experiences in students Final Projects

Project	Academic programme
Learning methodological strategies for children with Asperger	Degree in Telematics Engineering
Mobile application for people with cerebral palsy	Degree in Telematics Engineering
Mobile application for the Transfusion Centre and Tissue Bank	Degree in Telematics Engineering Degree in Computer Engineering
Environmental impact study of electrical pylons in a neighborhood	Degree in Electric Engineering
Design of an interactive game for people with cerebral palsy	Degree in Computer Engineering
Reduction of waste valorization of a recovery second hand-objects entity and software creation	Degree in Computer Engineering
Web design and promotion of sociocultural entity actions	Degree in Computer Engineering
Mobile application for children with autism who get lost	Degree in Computer Engineering Degree in Telematics Engineering
Project on water management	Degree in Chemical Engineering
Standardization of plants for the treatment of drinking water in the region of Orellana (Ecuador)	Degree in Chemical Engineering
Tecnhology innovations in cerebral palsy	Master's Degree in Technology and Engineering Management

Table 4. Service Learning Programme Engineering projects in academic courses

Project	Courses with SL component	Academic programme
Mobile application for via ferratas (climbing route) and evaluation of its usability	Human-computer interaction	Degree in Computer Engineering
Distribution and water management for a Community Gardens project	Hydraulics	Degree in Mechanical Engineering
Project design and manufacturing process of equipments for Higher Education Institutes	Mechanical technology	Degree in Mechanical Engineering

Conclusion

The URV's commitment to institutionalizing the SLP is, indeed, a means of incentivizing and promoting USR through socially innovative projects. This has been possible at the URV thanks to the wide range of social, cultural and environmental projects that are available to the members of the university community.

The SLP provides a space where groups dealing with issues such as the needs of individuals with different types of disability, the promotion of health, responsibility for animal welfare, the promotion of culture and traditions, the conservation of natural spaces and the defense of the rights of vulnerable groups can make themselves heard, encounter like-minded people and create synergies.

Engineering SL projects implementation in our university have had a smaller impact than in other URV studies (such as social and legal sciences, health sciences or even architecture studies). In order to promote SL presence in engineering faculties and schools, a team of four faculty members and SL staff member began to work in an impact study of SL at the institution, with special importance in the implementation of strategies in those areas where SL has a smaller presence.

References

1. Beltrán, I., *et al.*, *La responsabilidad social universitaria, el reto de su construcción permanente*, 2008. Available in http://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-28722014000300001
2. Higher Education Institutions & Responsible Research and Innovation (HEIRRI) Available in https://issuu.com/heirriproject/docs/d2.3_heirri_database_-_wp2_stock_ta
3. International Association of Universities, *In Focus. Social Innovation: Challenges and Perspectives for Higher Education*, 2015. Available in http://www.iau-hesd.net/en/news/2463-iau-horizons-211-focuses-social-innovation-challenges-and-perspectives-higher-education
4. Marquès i Banqué, M., *La dimensión docente de la Responsabilidad Social Universitaria: la institucionalización del aprendizaje servicio en la Universitat Rovira i Virgili*, 2014. Available in http://www.urv.cat/media/upload/arxius/aprenentatge-servei/Jornades%20i%20congressos%20APS/MMarques-%20RSU%20-%20APS.pdf
5. Ministerio de Educación, *La responsabilidad social de la universidad y el desarrollo sostenible*, 2011. Available in https://sede.educacion.gob.es/publiventa/descarga.action?f_codigo_agc=14925_19
6. Universitat Rovira i Virgili, *Documento marco del Programa de Aprendizaje Servicio*, 2012. Available in http://www.urv.cat/media/upload/arxius/aprenentatge-servei/Docs%20APS/DM_APS_cast.pdf

S-5

Influence and Possibilities of Cloud Computing in Engineering Education

Juan V. Capella[1]*, Luis Escolar[2]

[1] Universitat Politècnica de València, Dept. of Computer Engineering.
Camino de vera s/n 46022 Valencia
[2] Bits & Chips (www.bitschips.com)
**jcapella@disca.upv.es*

The cloud is a new environment that is changing the hardware infrastructure landscape around the world, defining services very well and influencing not only the way of working, but also the necessary training in the ICT world. How will it influence the model of university education? Will it drag the university education? Is it a real threat to the current training? How will the university respond? In whose hands will the formation of the future lie?

In this line, this work, rather than strictly dealing with cloud computing technology, presents experiences and ideas for the use of available services of cloud computing as a tool both inside and outside the classroom / laboratory, which allows us to take advantage of the motivation that these technologies arouse in the students and the possibilities of them to extend the learning process at any time and place, considering that like any other tool, it can be positive or negative depending on the circumstances, the needs of the students, the learning objectives or the educational activity to be carried out .

As advantages of the application of the cloud services we can highlight that they enhance student participation, eliminate time and space barriers to carry out any task, facilitate access to digital content, at any time, and the possibility of sharing them in any place. It is what is known as ubiquitous learning. This is usually defined, as the learning that occurs anywhere and at any time.

They also generate a great motivation in the students by the amount of applications available, innovative and that allow to enhance creativity, and of course they facilitate access to infinite quality educational content, as well as interactive activities that allow to offer a follow-up for the evaluation.

To adapt and encourage collaborative learning to new paradigms, it is necessary to study the application of new tools that favour such learning in the ubiquitous environments that currently prevail, and that can offer so many benefits. The cloud services of Google, by virtue of being free and universally known, constitute a pillar that allows for the reinforcement of learning and evaluation in teaching, in any field, academic, private, public, even during the early stages of Education. We focus in most cases on writing, conjecturing and betting on the use of tools that help in the teaching tasks during the not so early learning stages and we put aside their application in children's cycles, where the presence of digital resources tablets and mobile devices in front of the classic blackboard has so much weight. Undoubtedly, the Internet connection and affordable technological means allow to introduce the use of these online tools in an almost transparent way, where it is not necessary to perform any installation and the only associated cost is the training, which is in many cases a determining factor for successfully apply these new learning paradigms that will greatly improve the teaching - learning process.

Services used outside the classroom

For work outside the classroom, applications such as Coogle (https://coggle.it/?lang=en) that allow developing conceptual maps are also very appropriate, since they favour the student assimilating the contents by asking them to make a conceptual map about a subject treated.

On the other hand all the multimedia resources, teaching videos, etc. that the teaching staff can develop adhoc or can select from repositories like the institutional repository of the UPV Riunet (https://riunet.upv.es) that as you can see in figure 1 are accessible at any time and place from mobile devices, resulting in good support and guidance for the student's work outside the classroom.Figures/Tables should be included in the text.

Finally, indicate that there are applications such as Google Drive that allows you to share all types of files and facilitates work in a remote group, or the shared Google agenda that can allow us to place work delivery dates, exams, follow-up tutorials, control of class attendance, support for methodologies based on gamification, among others.

Figure 1. UPV Cloud repository: Video-lessons, multimedia materials, virtual labs, etc

Services and applications used within the classroom / lab

In the classroom, it is often very useful to quickly know the level of our students on a specific topic, their prior knowledge or their opinion on a topic. For these applications, such as Menterimeter (https://www.mentimeter.com), Socrative (https://www.socrative.com) or

Kahoot (https://kahoot.com) are very suitable, allowing to carry out the survey or test the students using their mobile devices as if they were a game and showing the teacher the results immediately, both numerically and through graphics.

Applications of augmented reality such as layar (https://www.layar.com), facilitate novel experiences in classroom or laboratory practice. In general terms, augmented reality consists of the vision through a device of a physical environment of the real world, whose elements are combined with virtual ones (usually superimposed information) for the creation of a hybrid reality in real time.

Conclusions

Cloud computing is a reality that is generating a great expectation in education due to the large number of services available, which with the appropriate methodology can be a great resource for improving the learning process.

In this paper we will provide some guidelines and applications that allow us to take advantage of the potential of cloud services both inside and outside the classroom / lab, which are giving good results in higher education environments.

References

1. Janosch Zbick , Bahtijar Vogel, Daniel Spikol, Marc Jansen, Marcelo Milrad, *Mobile, Ubiquitous, and Pervasive Learning*, 406 (11) , 193-222, 2015.
2. Yi-Wen Liaoa, Yueh-Min Huangb, Hsin-Chin Chenb, Shu-Hsien Huangb, *Computers in Human Behavior*, 13 (43) , 313-323, 2015.
3. Escolar, L., Capella, J.V., *Virtual USATIC 2016*, 2016

S-6

Educational Gardens as a University Multidisciplinary Teaching Resource: Experience in University Jaume I

Leonor Hernández López[1]*, Salvador F. Torró Cueco[1], Lidón Monferrer Sales[2], Concepción Calvo Más[2], Carmen Jose Emo Barberá[2], Rosa García Puchol[3], Pascual M. Ayet Cubero[3], María López Piñon[3]

[1] Dep. Mechanical Engineering and Construction. University Jaume I. Castellón. Spain
[2] Dep. Department of Education and Didactics of Specific Subjects University Jaume I. Castellón. Spain
[3] Taller de Jardinería de Cáritas Diocesana Segorbe-Castellón. Spain
*lhernand@uji.es

The project carried out around the educational gardens has been a multidisciplinary experience coordinated between several departments of the Universitat Jaume I of Castellón (UJI), the Workshop of Vocational Training in the speciality of Gardening, Nursery and Ecological Horticulture of Cáritas Diocesana de Segorbe -Castellón (CFO Worshop) as well as other professionals with extensive experience related to the topics addressed. The project has involved both students and teachers of Degree of Agri-Food Engineering and Rural Areas, Degree Primary Teacher Training and the Vocational Training Workshop. Throughout the project, learning activities of different university degrees were combined using the educational gardens as scenario. In addition, CFO Workshop, a non-university training entity with a high social commitment with extensive professional experience in the specific field, has also participated as a key external collaborator. The main goal was that the university students with different profiles, design and implement an educational garden within the university campus during one course. In the first semester the students of Agri-Food Engineering presented their proposals for an educational garden in a specific location within the university. During the second semester, some of the previously presented ideas from the engineering students for the educational garden were selected and implemented by the students in the Degree of Primary Teacher Training. Different results were obtained: the implemented educational garden can be used as learning tool for both engineering and educational degrees, the engineering students followed a service learning activity and also that the education stu-

dents can learn from a practical point of view the use of an educational garden as future professionals in the primary education. The experience has been evaluated by all the participants as very satisfactory, with what will continue to be implemented and improved in future editions

Introduction

The teaching innovation of this proposal focuses on the use of gardens as a training space, didactic resource and educational context for university teaching-learning in the environmental field. This instructional strategy has been coined in the USA as Garden-Based Learning and includes "the programs, activities and projects in which the garden is the basis for integrated learning, in and between disciplines, through active, motivating, and real-world experiences". The great versatility that the educational gardens present, favours the interdisciplinary nature of the project, that has involved the participation of teachers and students from different university degrees.

Another key innovative piece in this project is the collaboration between the interdisciplinary team of the UJI, with different primary schools around the university with around the university with educational gardens and also with the Workshop of Gardening and Nursery of Cáritas (hereinafter CFO Workshop) (Barrio de San Lorenzo, Castellón) (see Figure 1). This vocational training workshop is aimed at unemployed young people between 16 and 20 years old at risk of social exclusion. During the workshop both technical-professional content as well as social skills, personal and work habits are taught, with the objectives to develop their personal maturity and increase their chances of accessing the labour market.

Throughout the project, environmental training activities carried out in the educational gardens, the collaboration of the university educational community, both doors in and out doors, in this case with a non-university training entities has been promoted.

Results and Discussion

The project has been carried out during the 2018/2019 academic year, mainly involving teachers and students from the Degree of Agri-Food Engineering and Degree Primary Teacher Training. The methodology and activities to be followed in the project consist of the phases / activities linked to educational gardens and presented below.

PHASE 1. Identification of joint training actions

Meetings among the different members participating in the project to match specific competences of the subjects involved in the project, mainly Irrigation in the case of the Agri-food engineering and Teaching Natural Sciences in the case of Primary Teacher Training

PHASE 2. Design of joint training actions

Selection of teaching / learning methodology to be applied in the training action, as well as scheduling and preparation of training materials, of some of the training actions identified in Phase 1 of the project.

PHASE 3. Implementation of joint training actions

Those mature training actions, with resources available for their implementation and with possibilities of adjustment of semesters of the 2018/19 academic year were be carried out

PHASE 4. Evaluation of joint training actions

Since the formative actions carried out have been new in the subjects of the different participating educational levels, the satisfaction of the participants with respect to different axes has been collected as well as the information on possible improvements to be implemented in new editions.

PHASE 5. Compilation of joint training activities carried out

Information has been collected in a systematized manner of the joint actions carried out, so that they can serve as a framework and example for the implementation of future similar actions

PHASE 6. Dissemination of the results of the project

Once the part of realization of the formative actions has been completed, a stage has been taken to present the project in the media and also in seminars, conferences, meetings and congresses.

Figure 1. Visit with the university students to CFO Worksho (left) and CEIP Castalia (right)

Once phases 1 and 2 have been carried out, the joint activities planned to be carried out during the 2018/2019 academic year have been the following:

- Identification from the teachers of both degrees about the requirements to be met by the design of the educational garden in the university
- Presentation to the Irrigation students from agri-food engineering degree about the educational garden that they have to design in groups during the development of the subject (september to December) as part of their evaluation
- Visit with the irrigation students to good practices of educational gardens near the university (CFO Workshop, CEIP Castalia, etc) (see Figure 1)

- Development of the proposals of different designs for the educational gardens from the different groups of irrigation students supervised by the teachers, technitians, etc. This work has been proposed as a service learning project in which students have been grouped into "companies" whose mission was to propose the design of the educational garden in an specific location of the university. For this they have had at their disposal different visits to the "client" as well as advice from professional experts on the subject.
- Presentation open to the public about the irrigation students educational garden proposals, where the client, the teachers, the students from Degree Primary Teacher Training, CFO workshops and different teachers from primary schools with educational gardens attended, commented and evaluated the different student proposals (see Figure 2)

Figure 2. Presentation of irrigation student's proposals

- Selection an implementation of ideas from the proposals from the students and teachers of Degree Primary Teacher Training.

Figure 3. Implementation of ideas for the education garden from the Degree of Primary Teacher Training

The approach of the project has been something new both by the teachers involved, with what is very motivating on the one hand, but also represents a path to be explored that presents many unknowns to be solved as it progresses along the way.

The capacity of the working groups to solve the different problems that have arisen during the implementation have been solved thanks to the long experience of joint collaborations between the participants, mutual trust and close collaboration between the different multidisciplinary fields.

In order to collect the impressions of the participants of the project (students and teachers more actively involved in the different activities, as well as those attending the final day of presentation of the project) as well as to propose possible improvements in future editions of this type of project activities, surveys were carried out both in face-to-face discussion groups and in anonymous surveys. The evaluation of the participants was clearly satisfactory

Conclusions

The conclusions obtained throughout the project have been:

- Improvement of the specific and transversal competences (especially social responsibility and team work) of the participating students through training activities to be carried out in the educational gardens.
- Approach of students to situations close to the development of their profession. The students of each degree of the UJI have developed formative experiences in the educationalgarden related to their specific competences, so that the garden has served as a testing ground for the practical implementation of theoretical knowledge and is aligned with the improvement of the employability of the student
- Promotion of the interdisciplinary collaboration of teachers and students of the UJI, as well as cooperation between different educational areas and of these with the professional sector through joint training actions.
- Improvement of the opening of the university to society, by proposing training actions in collaboration with other local training entities with high social impact and with external professionals.
- On-site knowledge of good practices in the use of gardens as a training tool in the university environment.
- Dissemination of experience, both in the academic and social fields

The project has served as a first experience of multidisciplinary coordination between different educational levels, with the educational garden as the central axis of learning activities.

Acknowledgements

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vironmental gardens as a multidisciplinary collaborative learning tool, and on the other hand the SPIE-E2SR(Integració progressiva de la competència de Sostenibilitat en assignatures dels graus d'enginyeria) seeks to work on competencies associated to the University Social Responsibility in the teaching in Degrees of Engineering by means of the Service Learning.

S-7

Service-Learning Experiences in the Degree of Industrial Design and Product Development Engineering

R. Izquierdo[1]*, M. Royo[2], M. Carlos[2], L. Cabedo[1], V. Aparici[1], R. Oliver[1], J. Ortega[1], A. Reina[1]

[1] Departamento de Ingeniería de Sistemas Industriales y Diseño. Universitat Jaume I, Avda. Vicent Sos Baynat s/n, 12071 Castellón, Spain

[2] Departamento de Ingeniería Mecánica y Construcción. Universitat Jaume I, Avda. Vicent Sos Baynat s/n, 12071 Castellón, Spain

**rizquier@uji.es*

Introduction

Society demands from the University to be an active actor for society transformation, and not only a centre of research and training of highly qualified professionals. According to Castells [1], the University has the task of adapting to the many nowadays' changes, such as those in the information and communication society, the social networks, a neoliberal economic model and the delocalization and decentralization of knowledge.

Indeed, civic responsibility and social commitment are considered as important values for a proper professional development. So, these aspects ought to be considered into professionals' competences; whose integral formation is the focus for higher education [2]. Thus, the training of professionals, that are both competent and committed with the social development, constitutes nowadays a core mission in that educative context [3]. This holistic and integrated vision of education pursues the formation of able citizens, capable of adapting to the current changing, complex and inconstant social context.

Many Universities have institutional strategies and plans around social commitment, in an effort for University to be an agent for social change, both in the close, local environment and the globalized world. However, students scarcely get involved in these types of actions and, when they do so, they are usually carried out in extra-curricular facets.

So, the authors of this work consider that, additionally, actions and activities aimed for working and developing social commitment responsibility can be considered as a part of the students' formative process. Nevertheless, there can be some difficulties in integrating these competences within the structure of conventional subjects. Then, the teaching-learning process becomes more complex and requires of new methodologies and approaches; especially in some fields, such as engineering, where the interaction with disadvantaged people and groups is not as evident as in other disciplines. So the implementation of novel learning methodologies can be helpful in order to achieve that purpose.

Therefore, we consider essential to address efforts devoted to propose educational approaches that enables the introduction of the new competencies associated with the sustainability. The aim for that is the formation of not only qualified technical specialists but also professionals who are competent and committed to their surroundings [4]. Civic responsibility and social commitment are thus considered as values to be linked to their professional careers; therefore these abilities have to be trained during their educative period, as a highlight amongst the tasks higher education has to fulfil [2]. University social responsibility seeks for the public good and advocates a more fair and democratic society, and directs the educational model and the teaching activity towards this direction [5].

Among the new teaching methodologies, perhaps the one that suits the best this purpose for the field of engineering is the Service Learning (SL), a learning method based on an experience that arises from a social request [6]. The Chilean Education Ministry [7] states that SL results in community service pedagogical projects that are integrated in the curriculum. By means of these projects, students apply, verify and go more deeply into their knowledge, as well as the provide solutions to community problem; so they discover, apply and fathom out the concepts of their discipline and their relationship with real situations and the solving of concrete problems.

Therefore, SL is a form of education based on experience that responds to a social demand. With this method of teaching, learning occurs through a cycle of action and reflection through which students work with other colleagues in a process of applying what they have learned to the problems of the community. At the same time, the students reflect on the experience of pursuing real objectives for the community and increasing their own understanding and skills. It is, in conclusion, a methodology where students have to face up to community problems, seek for and think over real objectives thus boosting their own comprehension and skills, and developing multiple human dimensions while they cultivate civic and social responsibilities [8].

This tool is proving to be an excellent vector for the integration of sustainability and University Social Responsibility in the engineering subjects, since it can be applied in a relatively simple way to engineering problems and projects, thus allowing its integration in the curricula. In this sense, if the service in question is directly related to the content of the subject or subjects, it permits not only to work on its academic content, but it also provides a framework in which the student can learn about complex social problems and their role as engineers in them [9-11]. Concretely, when considering the 'service' approach of this methodology, two side effects arise:

a) First, an extra-curricular agent is involved, who is the potential beneficiary of the service. That provides the experience with a very highly professional dimension, as it transcends the traditional academic projects the teacher is to assess.
b) Secondly, the human side of the project, which makes students to get more deeply involved in their development; thus making their teaching-learning process more effective.

Methodology

In the present communication, the SL will be presented as a very powerful methodological tool, which can be applied in engineering subjects relatively easily, illustrated by both past experiences and present projects that are being carried out at the Universitat Jaume I.

These actions have been developed in a coordinated manner between two subjects of the second course of the degree of Industrial Design and Product Development Engineering of Universitat Jaume I at Castellón de la Plana. In these experiences, students have worked throughout a whole academic year in designing a product which has been promoted by local collectives of dependent people, which have been changing year by year. So, every academic year, the experience has been carried out during its two terms, in a coordinated manner between teachers and students of two different subjects (Conceptual Design and Materials II), jointly with the technical staff of the residential homes, and the final users themselves.

So, diverse activities are normally programmed temporally for correctly applying this methodology. During the first semester, there usually are various meetings between promoters and professors, as well as the visit of students to the residential homes, which end in the realization of several conceptual ideation proposals for that year's product. In the second semester, the ideas are developed and studied in terms of usage and materials, and prototypes are materialized in workrooms. Finally the prototypes are presented and handed out to promoters and users.

The complexity of these experiences lies in various aspects:

- The horizontal coordination between different subjects, both in field of knowledge and typology, from the same academic year.
- The vertical integration of aspects from other subject of the degree, which have to be somehow taken into certain account (modelling and prototyping, mechanical validations, ergonomics…). Sometimes, these aspects belong to subjects that students have not followed yet, so that adds extra difficulties. But when they finish their project, they see they can overcome difficulties and better understand their discipline.

But, on the other hand, several benefits arise from these activities:

- Students acquire a more complete vision of the engineering and design processes, in the first years of their degree.
- Non-academic relationships are established with real promoters, which provide the projects with a professionalizing atmosphere.
- Students end up by feeling more confident about their capabilities and more prone to deal with challenges.

- Students extend their reflection, vision and execution of a design project far beyond their merely academic nature.
- Students become aware of social diversity as well as the importance of inclusivity in engineering and, specifically, in design processes.

Finally, these experiences were assessed in terms of its impact, by means of the analysis of the impressions of the stakeholders (teaching staff, students, technicians and final users). To do so, various surveys and interviews are developed, at the end of each yearly project, in order to obtain results, both qualitative and quantitative, which improve the comprehension on what these experiences meant for all the interest groups.

Conclusion

This methodology has been applied at its full extent during three consecutive academic years. The results provided by the students have improved over the years. It is important to highlight that it is a motivating and powerful experience that makes students reflect upon the design process, the collaboration with disadvantaged communities and the life. All the opinions collected, regarding the engagement, the participation and the change in the mindset of the students who had participated in the experiences, were positive.

The implication of the students, via the reciprocal visits to the promoters and the bonds that were established with the final users, made them more responsible about the final results. For that reason, their quality were higher.

It could be thought that, perhaps, the themes –and their development– in the framework of the SL methodology were more complex to develop than other topics proposed in previous academic years. Anyway, although at the beginning students are reluctant and think they will not be able to contribute improving the proposed product, the results showed that there were always interesting contributions, which were very much appreciated both by the promoters and by the final users.

For this reason, it can be said that the implementation of the SL methodology in studies which combine creative and technical fields, such as the Industrial Design and Product Development Engineering Degree, can improve the students' motivation towards subjects and their vision of these subjects as being interrelated to conform a unified discipline. Furthermore, SL provides them with a vital experience of collaboration that helps them thinking on design as a tool for the development and improvement of the quality of life of the people.

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References

1. Castells, M., *La Era de la Información. Economía, Sociedad y Cultura,* México: Siglo XXI, 1996.
2. González, V., *Revista de Educación*, 8, 75-187, 2006.
3. UNESCO, *Conferencia Mundial sobre la Educación Superior,* París, 5-9 de octubre, 1998.
4. Cabedo, L., *et al.*, En Andrés, A., *et al.* (Eds.), *Colección "Humanitats" n° 53,* Castellón: Publicacions de la UJI, 2017.
5. Martínez, M., *Aprendizaje Servicio y Responsabilidad Social de las Universidades,* Barcelona: Octaedro, 2010.
6. Eyler, J., *et al.*, *Where's the Learning in Service-Learning,* San Francisco: Jossey-Bass, 1999.
7. Chile, Ministerio de Educación, *Manual de Aprendizaje Servicio,* Chile: Mineduc, 2007.
8. Royo, M., *et al.*, *AEIPRO,* 2018.
9. Oakes, W., *Service-Learning in Engineering: A Resource Guidebook,* Providence: Campus Compact, 2004.
10. Bielefeldt, A.R., *et al.*, *International Journal of Engineering Education*, 26 (3), 535-546, 2010.
11. Huff, J.L., *et al.*, *Journal of Engineering Education*, 105, 43-69, 2016.

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