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A FOCUS ON TEACHING AND LEARNING SUSTAINABILITY AND SOCIAL COMMITMENT SKILLS

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INTRODUCTION

Technical development has reached a point of development and adoption by society where the impact of technical developments in the society and the environment has a deep and global impact. With great power comes great responsibility, as Ben Parker said in Spiderman's comic-books. Today's engineers need to be aware of the responsibility they bear. This awareness has to be raised during the education and training.

The adaptation to the European Higher Education Area (EHEA) has brought us the need for the inclusion of professional skills in the curricula of universities. There are many studies on the need to incorporate these skills (National Academy of Engineering, 2004; Cobb, Agogino, Beckman & Speer, 2008). The need for most of these skills was not discussed while others have been introduced without unanimity. On the other hand, teachers feel more comfortable teaching some particular skills that have been introduced because they have an idea of how to teach and evaluate them.

One of the professional skills commonly accepted as essential in the modern world (despite some detractors) is "Sustainability and Social Commitment" (SSC). Nevertheless it raises concerns among teachers due to the lack of formal knowledge about it.

Some of the common questions raised when discussing this skill are: What is sustainability? What is its relationship with my subject? What should my students learn? How should we evaluate the skill acquisition? (Forment, López, Carracedo, Almiñana, Poch, Velasco et al., 2013).

Several studies exist on the overall relationship between engineering and SSC (Huntzinger, Hutchins, Gierke & Sutherland, 2007; López, Sánchez, Cruz & Fernández, 2007), on how to include this skill in only some particular subjects (Shuman, Besterfield-Sacre & McGourty, 2005; Coyle, Jamieson & Oakes, 2005; Tam, 2007), or in a whole curriculum (Siller, 2001), in a bachelor or a master thesis (López, Sánchez, Vidal, Pegueroles, Alier, Cabré, et al., 2014) or even on how to evaluate it (GöBling-Reisemann & Von Gleich, 2007; McLaughlan, 2007; Colby & Sullivan, 2008). However, these studies do not solve a more complex and extremely important problem: that every teacher knows how it relates SSC competition with his subject.

If we really wish to develop skills for SSC as part of any academic degree, it is necessary to change our way of thinking, our attitude. As we wrote in the rationale of the track, objectives such as equity; local, international and inter- generational solidarity for the conservation of natural resources, and the preservation of cultural diversity must be included in our curricula. Universities must always be prepared to meet new challenges and adopt roles that focus on solving current or preventing future social crises (energy, ecology, food, finance, etc.). Therefore, preparing students to take up their active role in society so that they are able to participate and to solve any challenge at a local, regional, or international level is one of the university's foremost responsibilities. However, learning Sustainability requires new ways of thinking and new ways of teaching. Intellectual development, critical thinking and a systematic approach are necessary in order to progress from “ignorant certainty to intelligent confusion” (Felder & Brent. 2004). There are methods closely related with the very concept of sustainability, like Service Learning, a method of learning that integrates meaningful community service with instruction and reflection to enrich the learning experience. There are good practices and very interesting experiences introducing sustainability in the curricula.

In this track we would like to promote the discussion about how can we help students to develop an adequate sustainable vision of the world in which they are to live, since they will play themselves a vital role in the evolution of that world. We thought about some topics, such as Pedagogical Innovations involving Sustainability, Methodologies for Learning and Teaching Sustainability, Evaluation and Assessment of Sustainability Learning, New Learning/Teaching Models involving Sustainability, Sustainability Learning Tools and Curriculum Design. Also educational experiences can be shared in this track, such as Good Practices involving Sustainability, Laboratory and Projects Design and Designing Sustainable Projects.

But another important point in SSC education for engineering is the ability to learn outside the classroom: SSC can be reduced to an academic question, it is mainly a practical question, and students must learn how to apply SSC in the real world. For this reason it s also necessary to work in subjects such as Collaboration with NGOs, Campus as a Lab, Citizenship Education, and Community Problem Solving.

All of these subjects point out to the fundamental and fast growing multicultural perspective that should be included in the approach used to teach and learn SSC, once the global learning environment is available constantly at a click distance and students travel frequently, both for educational and for recreational purposes.

LEARNING SUSTAINABILITY AND SOCIAL COMPROMISE SKILLS

To acquire the SSC skills, there are three basic concepts that must be understood by students:

- To know and to understand the complexity of economic and social phenomena characterizing the welfare society, relating globalization and sustainability;
- To learn the social and environmental implications of the engineering practice;
- To acquire the ability to find solutions, in which technology, economics and sustainability should be well balanced.

The SSC concepts are closely related to sustainable development. Sustainable development is defined as the kind of development that meets the needs of the present without compromising the capabilities of future generations to fulfil their own needs (Brundtland, 1987). Fundamentally sustainable development is based on two fundamental concepts:

- The concept of "needs", in particular the essential needs of the poor, to which overriding priority should be given;
- The acknowledgement of existing limitations imposed by the state of technology and social organization on the capability of the environment to satisfy present and future needs.

In order to attain a sustainable development, it is essential to control the environmental footprint. The ecological footprint, as stated by Wackernagel and Rees (1998), can be defined as the area of ecologically productive land (crops, pastures, forests and aquatic ecosystems) required to generate the resources used, and to assimilate the waste produced by a defined population at a specific level of life development, forever, wherever this area might be.

The challenge for SSC is to question what demands actually meet a need, and what needs have yet to be established on demand. SSC implies a global vision. Although it is often reduced to issues involving the environment (ecology), a sustainable solution must address problems in three major areas: environmental impact, economic cost and social implications. Any "sustainable" solution to a problem must take into account these three aspects.

As academics, we are bound to emphasize that the products of our students (future engineers) should be technically appropriate, robust, economically viable, taking users into account (accessibility), and at a sustainable environmental cost.

What students should also learn is not necessarily that problems exist that they need to be aware of, nor that they should show solidarity, be committed, or ecological but rather the relationship between the profession of the computing or mechanical or electrical or civil engineer and professional ethics, how to compute the cost of social and environmental solutions, and above all the impact of their engineering work (López Sánchez, Garcia, Alier, Piguillem & Velasco, 2011).

SSC AND ENGINEERING EDUCATION AND TRAINING

Universities must always be prepared to meet new challenges and adopt roles that focus on solving current social crises (energy, ecology, food, finance, etc.) (GUNI, 2008). If we really wish to develop skills for Sustainability and Social Commitment (SSC) as part of any engineering degree, it is necessary to change our way of thinking. Therefore, preparing students to take up their active role in society so that they are able to participate and to solve any challenge at a local, regional, or international level is one of the university's foremost responsibilities.

Though the EU has set very well defined targets in what concerns Sustainability and Sustainable Development, through the politics and lines of action established in the 2020 program, education for sustainable development in higher education is gaining growing importance.

Thus sustainability is a key issue that must be kept in mind in any engineering degree and constitutes an important factor in an engineer's education. It is closely related with some of the ABET engineering criteria (ABET, 2003), namely:

3.c) The ability to design a system, component, or process in order to meet needs within realistic constraints, such as those posed by economic, environmental, social, political, ethical, health and safety issues, as well as manufacturability, and sustainability;

3.f) An understanding of professional and ethical responsibility;

3.h) The broad education necessary for understanding the impact of engineering solutions in a global, economic, environmental and societal context; and

3.j) A knowledge of contemporary issues.

A study carried out in 2007 by Huntzinger and colleagues (2007) showed that, while many universities in the USA included the concept of sustainability in their curricula, new learning methods were required to meet 21st century engineering requirements.

The Bologna agreement implied a general reduction of the contact time for "formal" teaching/learning, with an immediate consequence of increasing the specialization of the graduates (three - four year bachelor degrees).

Although it was intended that both teachers/instructors and students had to change their behavior towards education, and non-formal education should be pursued by students, the fact is that this can only be accomplished if students had already gained a certain maturity and responsibility that in most of the situations is not the case.

Hence to include such a broad matter in the curricula of every course represents a huge challenge, as to understand the full implications of any kind of project/technology, the professional should be able to know, even at an elementary level, the basics of many different sciences, which is no longer possible. In this way he should be able to work collaboratively in a group of experts and prevent future problems that could arise from lack of information/knowledge.

That is, the application of sustainability to real life problems is a matter of multidisciplinary nature that can no longer be addressed, in most of the cases, by the bachelors that are being graduated nowadays.

SSC has yet to be perceived as a fundamental concept in an engineer's training, and is still regarded as a "good to know" skill that is not directly related to an engineer's work. Although sustainability is as attitude that can only be really entrained from a long practice and different thinking, in some schools and faculties, sustainability has been taught as a single subject or in a few specific subjects. Some of these initiatives are based on learning with social services (social learning) (Jacoby, 1996), an experimental approach to education in which students participate in activities focused on human and community needs, which are planned beforehand to assure that students acquire the necessary knowledge and training. This type of training has been widely studied in relation to engineering (Duffy, Tsang & Lord, 2000) and has been applied to different programs, such as that at the University of Purdue (Coyle, Jamieson & Oakes, 2005) or the Georgia Institute of Technology (Watson, Lozano, Noyes & Rodgers, 2013). Comprehension of real world problems helps students to develop SSC skills and provides them with new perspectives. Furthermore, it helps them to learn better the techniques associated with engineering (Vanasupa, Stolk & Herter, 2009).

Finally, Colby and Sullivan (2008) have proposed 5 basic recommendations for the teaching of SSC skills:

1. Define professional responsibility and ethics in a manner that can be clearly understood;
2. Integrate these skills with other academic objectives;
3. Use active pedagogy for teaching;
4. Teacher involvement;
5. Extend involvement of public institutions.

These 5 points can be defined as key points for the spirit of this special issue.

PAPERS PRESENTED

In this special issue we present the following papers. First we have four papers that show how project based learning can be effectively used to learn the SSC skills. In "Developing an aquaponics system to learn sustainability and social compromise skills" we will see how a multinational and multidisciplinary team developed an aquaponics system whose goal is to contribute to reduce the strain on resources within 1st and 3rd world countries. And in "Learning sustainability by developing a solar dryer for microalgae retrieval" we see the development of a clean energy solution for drying microalgae. Last but not least in "Introducing ethical, social and environmental issues in ICT engineering degrees" we will see how the SSC skills have been introduced in the engineering studies in the Universidad Politécnica de Madrid. Finally we offer "A multicultural approach to teach sustainability". This work reports some results obtained from the Problem Based Learning (PBL) experience.

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