

Education for Sustainable Development through Service Learning in Engineering

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ABSTRACT

The Research Institute for Sustainability Science and Technology under the Master degree in Sustainability Science and Technology organises the course Action Research Workshop on Science and Technology for Sustainability (5 ECTS). The purpose of the course is to put together civil society organisations, local administrations, students and educators to collaboratively undertake responsible research, using transdisciplinary Action-Research methodologies through service learning.

Students work on service learning real projects, related to local sustainability problems, represented by a community entity. Action research methodology is used with a two-cycle approach. After finalising three editions a relevant conclusion is that during the process students faced conflict and frustration situations, within their team and with stakeholders. To face that, an Emotional Intelligence module was introduced in the course and helped students to solve some paralyzing situations. Therefore we suggest that engineering students need specific training in transdisciplinary learning and conflict resolution, otherwise they could collapse in frustration when dealing with real sustainability challenges.

Conference Key Areas: Sustainability and Engineering Education, “I want to contribute to solve local problems”, Engineering Skills

Keywords: Sustainability education, Service Learning, Emotional Intelligence

INTRODUCTION

Sustainability issues are widely recognized as wicked problems [1], which should not be considered as problems to be solved, but as conditions to be governed [2]. There is a general agreement on the need to reform scientific expertise, as it is required to deal with sustainability challenges, by developing new ways of knowledge production and decision-making. In that sense, Stephen Sterling [3] maintains that the nature of sustainability requires a fundamental change of epistemology, and therefore, of education. In relation to engineering education, the Barcelona Declaration [4] highlight the sustainability competences that engineering students should master when graduating.

The Universitat Politècnica de Catalunya (UPC Barcelona Tech), aware of the new sustainability competences that engineers should have, offers a master degree in Sustainability Science and Technology that trains students to become entrepreneurial professionals and agents of change for sustainability. Service learning is one of the pedagogical approaches applied in the master. The following sections explain the learning environment and the challenges and lessons learnt when applying such learning approach.

1 SERVICE LEARNING APPROACH

Service-learning is an innovative teaching and learning method with experiential character that integrates service to the community and critical reflection with the academic learning, personal growth and civic responsibility. It is powerful tool for learning and for social transformation, which responds to the ultimate goal of education: to form competent citizens capable of transforming society.

Service-learning is the necessary response to an educational system that is alienated to social needs [5].

There are two main mechanisms that make service-learning an effective educational tool: the process and results. Firstly, it causes a mental process that improves learning. Research shows that complex facts and ideas are best retained when knowledge is linked to Experience [6] and facilitates the transfer of skills and knowledge to real situations [7]. Therefore, when teachers create a reflective learning-service environment, it is likely to improve the understanding and remembering of complex material. Secondly, service-learning produces results of great interest to higher education. Studies show that service-learning contributes to develop critical thinking and problem-solving skills [8] [9], citizen participation, social responsibility and development of values and self-efficacy and self-confidence [8].

Service-learning increases awareness of social justice [10], teaches students to question society from a point of view critical and emphasizes social change rather than charity [11].

Through learning-service, students can develop a vision of the social justice and learn to analyse the issues that are encountered in your life with a critical look at injustices [12].

2 SERVICE LEARNING COURSE

The service learning pedagogical approach is applied in The Action Research Workshop on Sustainability Science and Technologies a course within the Master of Sustainability Science and Technology. It is a 5 ECTS (European Credit transfer System) course, which uses constructive and community oriented learning which has

shown to be the most efficient way to train students in sustainability science competences [13], [14].

2.1 Learning outcomes

When finishing the course students will have been trained in the following competences.

- To understand how their work interacts with society and the environment, locally and globally, in order to identify potential challenges, risks and impacts
- To reflect on the results of the service learning process in order to understand the social dynamics that appear when applying engineering approaches in real sustainability challenges

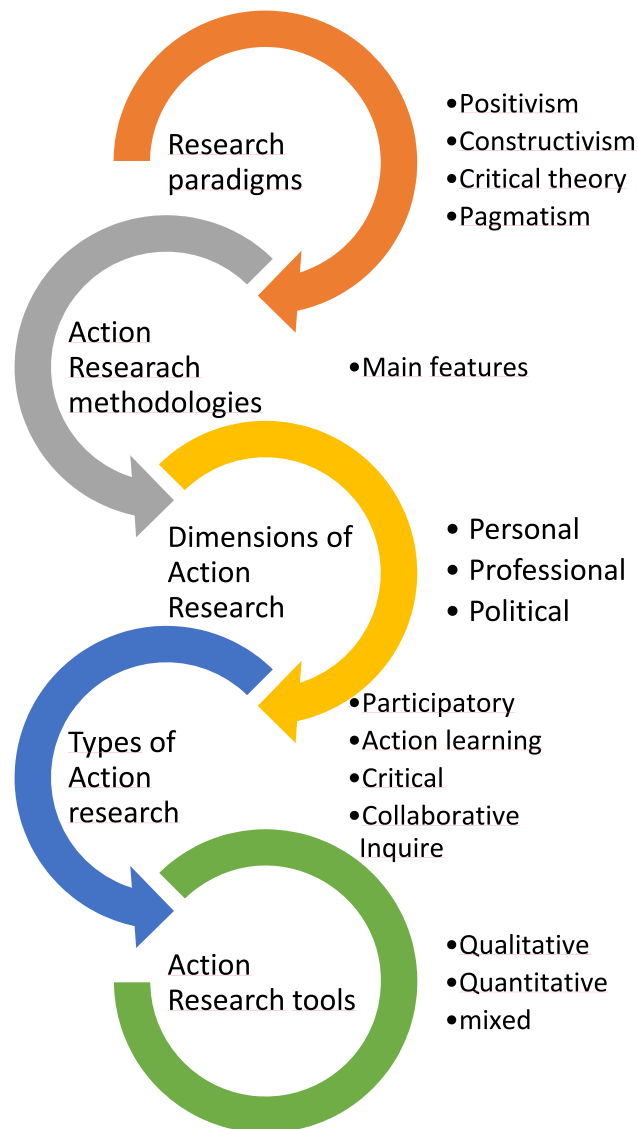


Fig. 1. Action research theoretical framework of the course

2.2 Course structure

The course is organized (Figure 1) around five areas: Research paradigms, Action research methodologies, Dimensions of Action Research, Research tools and Real projects. First students are faced with different research paradigms: Positivism, Constructivism, Critical theory, Pragmatism and their features in order to facilitate their reflection on the research that they may apply in their future work as engineers. Next,

students are trained in the main features of Action Research methodologies. Once students are familiar with the main characteristics of action research, they learn about the main types of action research: i) Participatory action research [15]; ii) Action learning [16] [17]; iii) Critical action research [18] and iv) Collaborative inquiry [19]. Students study their main features, pros and cons, methodological approaches and examples. Finally, students are trained in qualitative, quantitative and mixed research tools and methods typically used in action research: Conceptual maps, questionnaires, interviews, backcasting, complexity and network analysis, etc

They apply all their learning in Action Research in real sustainability projects under Service Learning paradigm [20] [21].

3 THE EXPERIENCE AT UPC

The course has been run for three years (2014, 2015 and 2016). We are currently running the 2017 experience. The course is organized around current sustainability relevant topics, broadly related to unsustainability aspects which are analysed in study real-life projects in local real situations, needs or challenges. Table 1 show the general topics for each course, organisations who lead their own real-life projects and the research question for each of them.

Table 1. Service learning projects ran at UPC

Topic	Stakeholder	Real-life projects	Research question
2014			
Sustainable clothing and slow fashion	Clean Clothes Campaign	Spanish fashion in Morocco	What a local clothing company can do to minimize labour exploitation risk, when pushed to find suppliers in Morocco?
	Slow Fashion Spain	A local booming sustainable clothing market	What are barriers and challenges faced by sustainable fashion initiatives in current market?
2015			
Energy poverty in Catalonia	Energy Bank Association BE - Municipalties Premià/Sabadell	Detection of motivations to participate in the BE in Premià	What are the factors that influence the decision to join or not the driver group of BE?
		Phase 1 of implementation of the Energy Bank in Sabadell	What key factors that encouraged real participation in a local energy program can be used for BE?
2016			
Energy poverty in Catalonia	Energy BE – Premià	Phase 2 of BE implementation in Premià: private sector	What affordable and sustainable offer could facilitate the organizations involvement to BE?
Gas Geopolitics	OdG- Debt Observatory in Globalization	MIDCAT, huge construction of a mega- pipeline for gas interconnection France-Spain	What is the capacity of this civil organized campaign facing to maximize transparency and public accountability?
		Gas imports of the Port of Barcelona	What is the city responsibility on the perpetuation of fuel energy model based on natural gas?
UPC's water management teaching	EWB- Engineers Without Borders	What kind of water management is promoted at UPC?	Does the curriculum and UPC research respond to ensuring the human right to water?

3.1 Assessment of the course

In order to evaluate the course, two explicit reflexive questions are asked to the students: *What have I learned in this course?* And, *What do I think about the course*

(structure, organization, timing, projects, etc.)? The results of the students' reflexions have been clustered in tables 2 and 3.

Table 2. Reflections of students about their learning

Topic	Relevant comments from students
Research methodologies	<ul style="list-style-type: none"> - <i>Qualitative and quantitative approaches are needed to see beyond the numbers.</i> - <i>I learned the relevance of qualitative aspects as we learned more from direct interaction with people than with quantitative data obtained by "R software".</i> - <i>The management of relations with qualitative research, which is not usually taught in tech universities, has been very stimulating</i> - <i>Qualitative data from interviews is a very inspiring process</i>
Transdisciplinarity	<ul style="list-style-type: none"> - <i>I have learned the relevance of stakeholders and the role they play.</i>
Real-life projects	<ul style="list-style-type: none"> - <i>To participate in a real project and to be in touch with real stakeholders has been very interesting</i> - <i>I liked to work in real projects</i>
Mutual learning	<ul style="list-style-type: none"> - <i>We learn to work with people from different disciplines and to improve our communication skills when working with professionals with different project management schemes</i> - <i>We learn to be more tolerant with our group mates that have different backgrounds and ways of working.</i> - <i>The most valuable point was the interaction with stakeholders from other disciplines, listening to their points of view and experiences in the topic.</i>
Robust knowledge	<ul style="list-style-type: none"> - <i>To realise that the different needs and concerns of stakeholders may shake the project process.</i>

Table 3. Reflections of students about the course

Topic	Relevant comments from students
Discussions in class	<ul style="list-style-type: none"> - <i>What I liked the most was the organization and group work in class, allowing us to listen and learn from each other</i>
Low directedness	<ul style="list-style-type: none"> - <i>There were many expectations at the beginning from all stakeholders and we felt a bit lost</i> - <i>The goal of the research should have been defined between the stakeholders which delayed the project, and was time consuming</i> - <i>The planning was confused and it took time to our self-organization with the stakeholders</i> - <i>I think that this course gives us too much freedom to make our choices, depending on which stakeholders we were discussing the topic with, the goal were changing...</i>

The main criticisms were related to the low degree of directedness at the beginning that for some was very frustrating, (the low directedness was deliberate in order to train students in dealing with stakeholders' different interests in real settings). In order to decrease the frustration among students, the course coordinators introduced an emotional intelligence workshop in the course

3.2 Emotional intelligence workshop

The module aims to allow students to obtain some experiential knowledge related to emotional intelligence and what the related competences are. These interpersonal competences, related to emotional intelligence are rarely included in curricula, although they have been widely studied and claimed [21] [22].

The workshop (2.5 hours) it starts with a framing theoretical introduction about emotional intelligence [23], multiple intelligences theory and related competences, always within the framework of sustainability [24] [25]. After that they participate in some exercises or dynamics proper to therapeutic theatre. The module follows the thread of the 5 domains of emotional competence: emotional awareness, emotional regulation, emotional autonomy, social competence, skills for life and well-being.

Participants recognize in an experiential way what the emotions involved in each of these domains of Emotional intelligence are, self-competence in all of them and how emotions can be perceived and expressed, understood, regulated and facilitated.

4 CONCLUSIONS

After the three years of the service learning programme, we have observed that students set out the importance of some topics and the difficulty they have to maintain them. Difficulties appeared at different points in the process, starting from the very beginning, when the problem formulation proved to be one of the most arduous task in the process. Another challenge arose with the accompaniment of stakeholders and the recognition of their role, during the whole process, because engineering students are not usually trained to work in wicked problems and moreover to work together with stakeholders. In this sense collaboration and communication with stakeholders was also challenging.

Finally, it is relevant to highlight that during the process students faced conflict and frustration within their team and with stakeholders. To face that, an Emotional Intelligence workshop was introduced which helped students to solve some paralyzing situations, which could have stopped the progress of the project. Therefore we suggest that engineering students need specific training in action research and conflict resolution. If not, they could collapse in frustration when dealing with real sustainability challenges.

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