ERASMUS Intensive Program in Sustainable Technology Development: Multicultural Constructive Community learning course for EESD applying Backcasting

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Abstract

The International Seminar on Sustainable Technology Innovation is a course offered in the framework of the master of Sustainability of the UPC-Barcelona Tech University and financed by the ERASMUS Intensive Program scheme.

The main goal of the course are: to connect experts, future researchers and policy-makers on real topics where long-term technological systems renewal is needed in order to fulfil sustainability requirements; to increase the understanding of a sustainable development in the long term and the role of technology therein embedded in systems; to increase the capability to apply foresighting, forecasting and backcasting; to contribute to the development of scientific work competences of students; to increase the capability of teachers to teach the approach of future imaging, foresighting, forecasting and backcasting and to become an experts' meeting point and create networking activities among different groups and institutions.

It introduces Backcasting scenarios methodology in real sustainability problems. The learning environment is international, transdisciplinar, intergenerational and intercultural. It includes stakeholders' dialogues and discussions.

The course is organized around current sustainability relevant topics that are analysed in study cases based in different contexts: going from developed to developing countries and from local to global cases. Students apply scenario methodologies to the study cases in order to set up the most contextualized sustainable strategies.

The course is structured in four phases: first the local situation analysis where students analyse the topic on their own countries/regions; then students are grouped in international multidisciplinary teams and define the state of the art of the case studies; afterwards students, lecturers and stakeholders meet in Barcelona where the course is run for two weeks and finally students analyse their learning experience in terms of competences acquisition.

The topics analysed in the course vary each year and are related to relevant sustainability challenges: urban solid waste management; food & drinks packaging waste; overfishing and marine ecosystem degradation; sustainable mobility, agro-ecology and sustainable community energy systems

In year 2013 UPC Barcelona Tech is running the sixth time the course and so far more than 130 students, 30 lecturers and 50 stakeholders have participated in the course from 15 countries.

This paper explains the learning environment and the challenges and lessons learnt when organizing such a course, and the learning results obtained by students.

1   Introduction

One of the UN Millennium Development Goals (UN, 2012) is directly directed to education. No one will discuss that education is a must for sustainable development, but so far there is no direct relation between educated societies with the highest rate of "educated" citizens and the highest sustainability (WWF, 2012). Sustainability demands a specific kind of learning; quoting E.F. Schumacher (Schumacher, 1973): "The volume of education… continues to increase, yet so do pollution, exhaustion of resources, and the dangers of ecological catastrophe. If still more education is to save us, it would have to be education of a different kind: an education that takes us into the depth of things". In addition, some authors call for a deep change in society to order to achieve more SD (whatever it is). SD is not just a matter of acquiring some extra knowledge. Attitude is also important. Moreover, it is often necessary to change social structures (Segalas et al., 2006).

Stephen Sterling (Stirling, 2005) maintains that the nature of sustainability requires a fundamental change of epistemology, and therefore, of education. He writes: *"Sustainability is not just another issue to be added to an overcrowded curriculum, but a gateway to a different view of curriculum, of pedagogy, of organizational change, of policy and particularly of ethos. At the same time, the effect of patterns of unsustainability on our current and future prospects is so pressing that the response of higher education should not be predicated only on the 'integration of sustainability' into higher education , because this invites a limited, adaptive, response.… We need to see the relationship the other way around—that is, the necessary transformation of higher education towards the integrative and more whole state implied by a systemic view of sustainability in education and society".*

In relation to technological education, the Barcelona Declaration (Barcelona Declaration, 2004) approved during the Engineering Education in Sustainable Development (EESD) conference in 2004 declares that today's engineers must be able to:

- Understand how their work interacts with society and the environment, locally and globally, in order to identify potential challenges, risks and impacts.

- Understand the contribution of their work in different cultural, social and political contexts and take those differences into account.

- Work in multidisciplinary teams, in order to adapt current technology to the demands imposed by sustainable lifestyles, resource efficiency, pollution prevention and waste management.

- Apply a holistic and systemic approach to solving problems, and the ability to move beyond the tradition of breaking reality down into disconnected parts.

- Participate actively in the discussion and definition of economic, social and technological policies, to help redirect society towards more sustainable development.

- Apply professional knowledge according to deontological principles and universal values and ethics.

- Listen closely to the demands of citizens and other stakeholders and let them have a say in the development of new technologies and infrastructures.

The Universitat Politècnica de Catalunya (UPC Barcelona Tech), aware of the new competences that engineers should have, offers a master degree in Sustainability Science and Technology. The aim of the master's degree in Sustainability is to provide advanced training in sustainable human development that enables students to understand the complex interaction between society, technology, the economy and the environment, so that they can tackle the social and environmental challenges inherent to sustainability: climate change, the depletion of natural resources, North-South imbalances, environmental justice, etc. This master's degree will prepare students to become entrepreneurial

professionals and agents of change for sustainability who will, depending on their specialization, design and assess global, sustainable solutions for the uncertain, complex scenario in which we live. They will take an interdisciplinary approach and ensure scientific and technical rigor in the diverse cultural and professional contexts in which they work. It becomes a highly demanded opportunity of teamwork and to mix with students of different knowledge cultures (Fry, 2003).

Within the Master course, there is the subject Sustainable Technology Innovation. These next sections explain the learning environment and the challenges and lessons learnt when organizing such a course, and the learning results obtained by students.

2   ERASMUS Intensive Program in Sustainable Technology Development

The Sustainable Technology Innovation (STI) course is a subject within the Master of Sustainability Science and Technology offered by Barcelona Tech University. It is a 5 ECTS (European Credit transfer System) course, which uses constructive and community oriented learning. Since 2012 the course is an ERASMUS Intensive Program (http://ec.europa.eu/education/erasmus/ip_en.htm) financed by the European Commission Education and Training programme.

2.1   Goals and learning outcomes

The goals and learning outcomes of the course are in line with to the Barcelona Declaration (2004):

- To increase the understanding of SD in the long term and the role of technology therein embedded in systems.

- To increase the capability to apply foresighting, forecasting and backcasting.

- To contribute to the development of the scientific work competences of students.

- To increase the capability of teachers to teach the approach of future imaging, foresighting, forecasting and backcasting.

- To equip UPC with the insight and capacity to transfer knowledge on future imaging and backcasting for sustainable development in the Masters in SD and further afield in Catalonia and Spain.
- To become an experts' meeting point and create networking activities among different groups and institution.

2.2   Methodology

The course is organized around a real and 'hot' topic which is chosen every year to give context to the participants' work. The topic is analysed first at the national level, and afterwards through case studies. The case studies are chosen in order to cover the broad spectrum of sustainability problems: from local to global and from developed and developing countries perspectives (Table 1). The content of the lectures and the dialogues is defined by a transdisciplinary committee, so that the most innovative and updated lectures on each issue can be analysed. Students, in multicultural and multidisciplinary groups, apply backcasting methodologies to the case studies, proposing strategies that would improve their sustainability.

The course is structured into 3 phases (Fig. 1):

Phase 1: Virtual, distance-based. This phase is divided in two steps:

First step: Local situation analysis. From March to May, students analyse the topic in their own countries/regions. The goals will be to introduce students to the sustainable topic of the year in their national framework. To report the results of this task, they will have to develop a poster with the state

of the situation (data and flows, system and technology solutions, regulation, social perception and so on), which will be presented on the first day of the third phase.
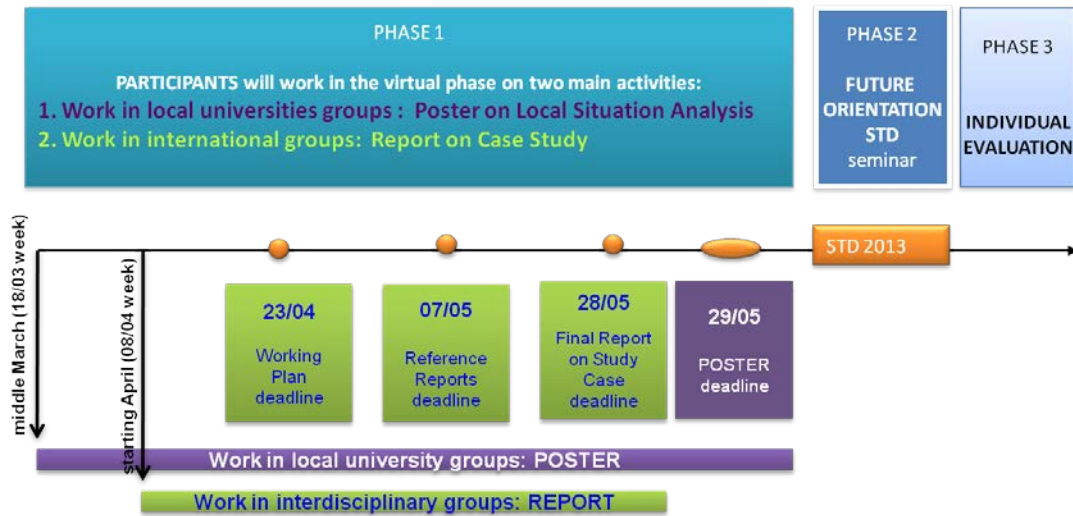

Figure 1: Phases and schedule of the programme.

Second step: Case study analysis. In May, students are grouped into international multidisciplinary teams and define the state of affairs in the case studies.

Phase 2: Seminar at UPC. In June, students, lecturers and stakeholders meet in Barcelona where the course is run for two weeks in a presential framework. There are two weeks of different types of learning methodologies (Figure 2): Poster presentation by students with peer review; lectures from expert professors; practical visits; interaction with stakeholders in debates; and group working sessions on the case studies, applying backcasting scenario analysis methodologies and assessment sessions. Practical visits draw the connection between theory and practice, related to the case studies. Finally, the students set up a final presentation and a report on applying backcasting to the case studies, in order to propose feasible transitions towards sustainable solutions.

Figure 2: Learning methodologies that are used in the presential phase of the programme.

Phase 3: Evaluation of the course. Students evaluate their learning experience in terms of competences acquisition.

Table 1: Topics and case studies analysed in the programme.

2008	Topic: Water sanitation and Treatment	
Case studies	Developing	Recovery of Morro de Moravia, a suburb of the city of Medellin established on a landfill, with serious sanitation problems and water shortages
	Developed	Water supply difficulties in the Barcelona metropolitan area, with a climate that is inexorably warming up and drying out
2009	**Topic: Urban solid waste management, food & drinks packaging waste**	
Case studies	Developing	Dematerialization in food and drink packaging, analysing Bulgaria
	Developed	Dematerialization in food and drink packaging, analysing Catalonia
2010	**Topic: Overfishing and marine ecosystem degradation**	
Case studies	Global	Atlantic Bluefin tuna is in urgent need of extensive international cooperation, required in order to ensure appropriate management of the species
	Local / Developed	Initiative to provide a figure of protection to an Environmental Protected Area (3000 ha approx.), at coasts of Garraf (Mediterranean Sea), taking into account: the entire ecosystem, the involvement of all stakeholders in the area linked to the sea and fishing
2011	**Topic: Mobility and global transport**	
Case studies	Global / Developing	The Guatemala's Technological Corridor project intends to build mega infrastructures to connect overland the Pacific to the Atlantic Ocean, with the target to convey goods disembarked from merchant ships
	Local / Developed	Mobility-related university activity affects the metropolitan area of Barcelona environmentally, socially and economically, with a lack of coordination between the different levels of territorial planning
2012	**Topic: Agroecology and consumption model**	
Case studies	Global / Developing	The COMPETE (Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems in Africa) project, addressed the interrelated problems of low quality of life, limited energy access, and lack of livelihood opportunities in rural Africa, that lead to a degradation of arid and semi-arid ecosystems through unsustainable land-use practices
	Local / Developed	*Salvem l'Ortoll* is a civil society movement that tries to safeguard a peri-urban space in Vilanova i la Geltrú (Catalonia), which is in state of deterioration. The gravity of the situation can cause this area is irreversibly damaged, leaving urbanization as its only possible future
2013	**Topic: Sustainable Energy Systems: Community Participation**	
Case studies	Local / Developed	The association of forest owners Massís del Garraf. An association of forestry owners of the Massís del Garraf (APF Massís del Garraf) was created in order to promote biomass extraction in a collective way and to try to reduce the costs of extraction and biomass collection
	Global / Developed	The European Energy legislation framework. The European Union has introduced its 20/20/20 targets to reduce climate change impacts and energy consumption, with the final target being to achieve a low carbon economy that promotes green growth and jobs to strengthen Europe´s competitiveness

2.3   Five successful years of the programme

The course has been run every year since 2008. During those six years, the topics and case studies have been based in the *five challenges* of the *Pla UPC Sostenible 2015* (UPC, 2009), chosen to concentrate efforts on the key issues that society demands: *Construction, energy and climate change; Integrated water management; Socially responsible technology; Land use planning, mobility and logistics; and Material cycles, eco-design, waste management*. Table 1 shows the topics analysed and the cases studies worked out by the participants.

During these 6 years, more than 160 students, 25 lecturers and 50 stakeholders have participated in the seminars.
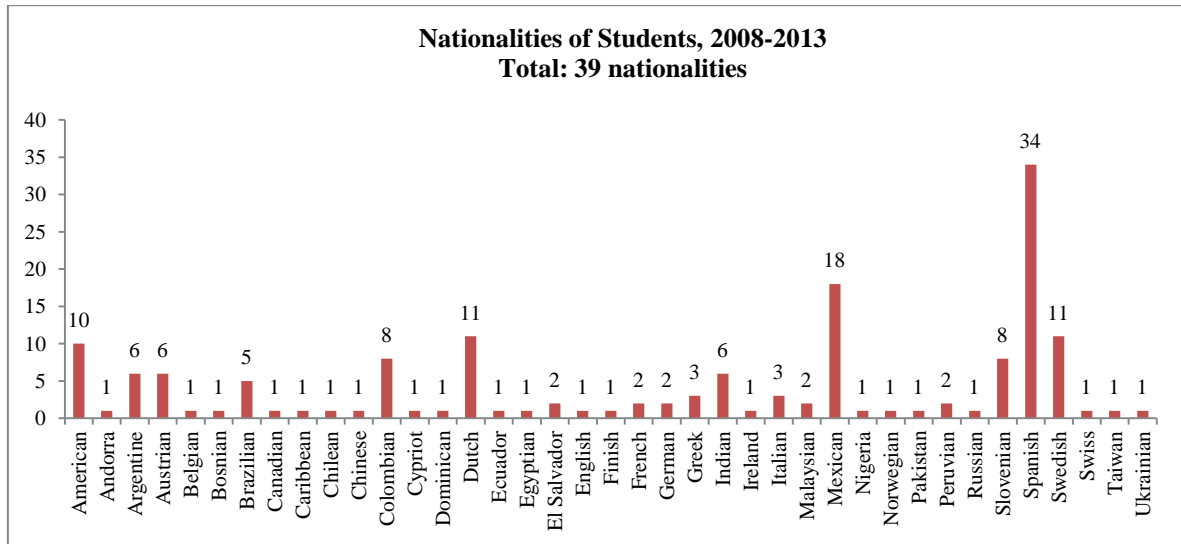
Nationalities of Students, 2008-2013
Total: 39 nationalities

Figure 3: Multicultural atmosphere: nationality of students.
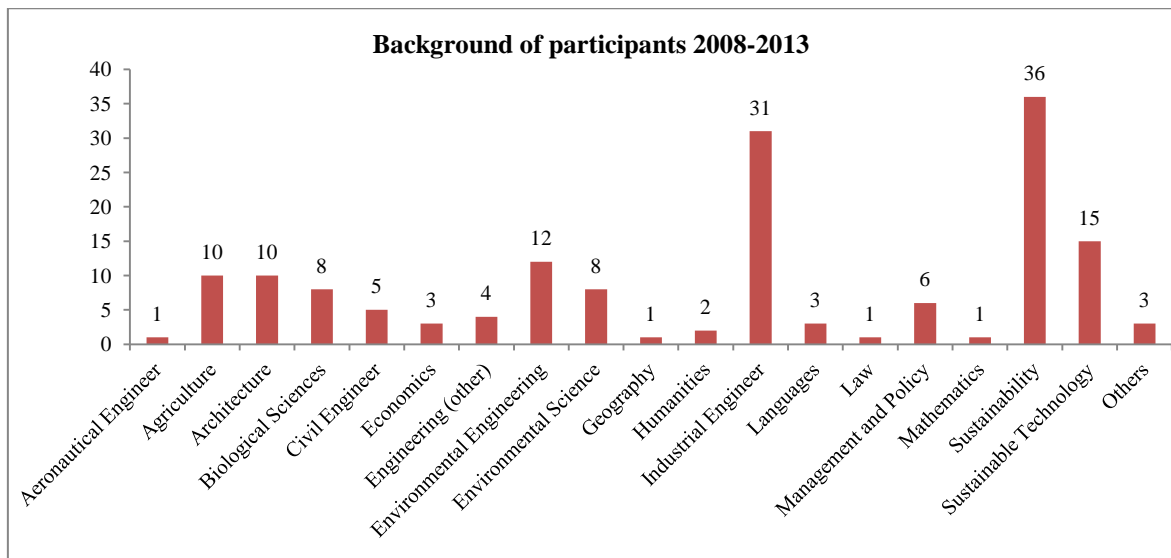
Background of participants 2008-2013

Figure 4: Transdisciplinary atmosphere: Background of participants.

2.4   Programme assessment.

During the course two types of assessment are carried out:

Students evaluation: Students are evaluated by their communication skills in terms of poster design and presentation, and the report communication value; their capacity to work in multidisciplinary and multicultural atmosphere in terms of team-building competence; the cognitive thinking contained with the content of the final presentation and report, in terms of correct application of the backcasting methodology to the case study challenges. Upon completion of the virtual and the presential phase, students and teachers have to submit an essay assessing their individual experiences, expectations, and overall assessment of learning achieved. Overall, students are evaluated during all three phases. In every phase students are supervised either by their home university, seminar assistants, project staff or the academic panel. They will receive grades for every piece of work they hand in. In the end, their final grade will be composed of 4 different parts: participation, report (divided into poster and virtual report), final assignment (divided into communication, presentation and content) and the final individual evaluation.

Course evaluation: After completing the course, evaluation questionnaires are handed out to all participants at the presential phase in order to first evaluate the organization of the seminar, and second the academic competences and learning environment. Thus, the seminar is assessed (scored from 1 to 5) in terms of the content (plan, objectives, information provided, workload, interest) and organization (facilities, logistics, accommodation, organizers involvement). Lecturers and external collaborators are evaluated in terms of their communication skills, introduction of interesting elements for the discussion and reflection, and support for the students' work. Finally all the pedagogical methodologies (pre-work, students' presentations, lectures, dialogues, visits, study cases) are evaluated.

3   Results

The course is very successful among students of masters related to sustainability, as every year the number of students and universities participating in the course increases.

The course evaluation shows a high satisfaction of the students in relation to the content and organizational issues and also to the pedagogical methodologies applied. See figures 5 and 6.
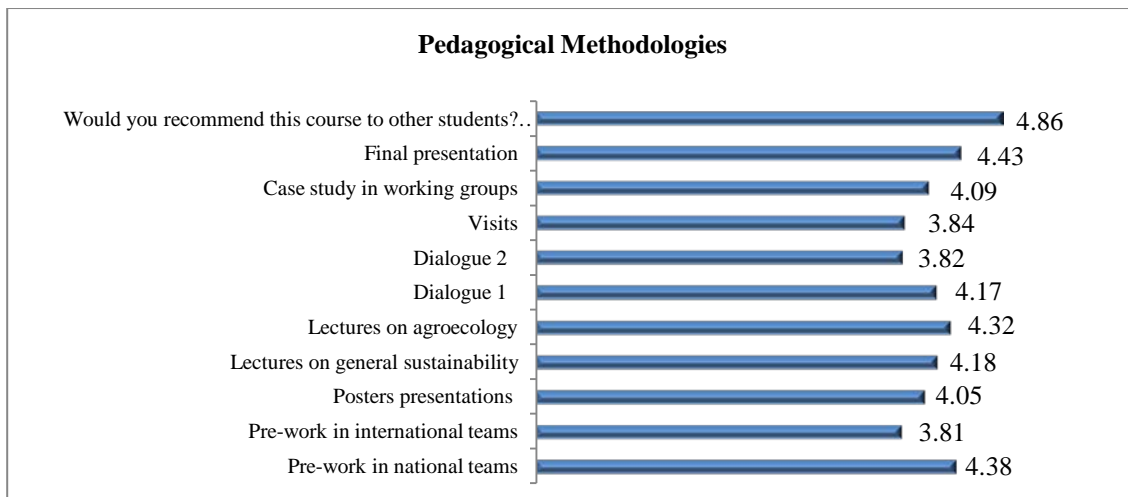

Pedagogical Methodologies

Would you recommend this course to other students?...	4.86
Final presentation	4.43
Case study in working groups	4.09
Visits	3.84
Dialogue 2	3.82
Dialogue 1	4.17
Lectures on agroecology	4.32
Lectures on general sustainability	4.18
Posters presentations	4.05
Pre-work in international teams	3.81
Pre-work in national teams	4.38

Figure 5: Assessment of pedagogical methodologies. (1 absolutely disagree, ..., 5 absolutely agree). Year 2012.

4   Conclusions

After 5 years, the Seminar has achieved much more than a purely cognitive theoretical type of learning. The community-oriented case studies, together with the stakeholders and social movement dialogues, bring together academia and society. The course has been shown to be an area with enormous potential to bring social needs to the world of ideas, beyond a learning space.

In relation to the objectives of the course, it uses inter and transdisciplinary and transformative learning approaches needed for sustainable development.

In order for students to become change agents for sustainability, it is crucial that stakeholder involvement and participatory processes are contained within the learning process including problem definition, analysis (current situation, vision) and the advancement of possible.
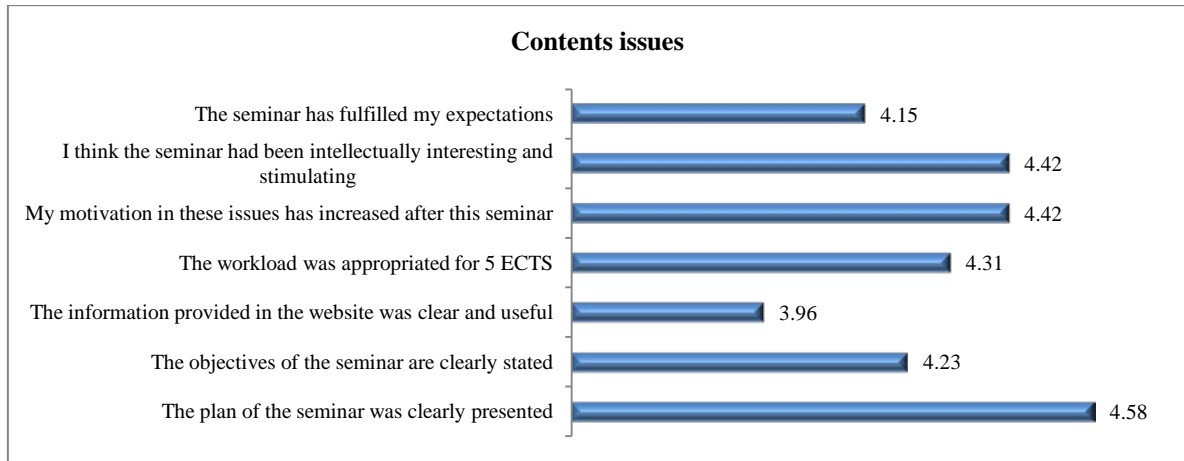
Contents issues

The seminar has fulfilled my expectations	4.15
I think the seminar had been intellectually interesting and stimulating	4.42
My motivation in these issues has increased after this seminar	4.42
The workload was appropriated for 5 ECTS	4.31
The information provided in the website was clear and useful	3.96
The objectives of the seminar are clearly stated	4.23
The plan of the seminar was clearly presented	4.58

Figure 6: Assessment of the programme. (1 absolutely disagree, ..., 5 absolutely agree). Year 2012.

Acknowledgments

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