COMPARATIVE STUDY ON TEACHING METHODS FOR ENVIRONMENTAL COURSES

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Abstract

Environmental studies require both incremental and novel technical solutions. Both incremental and novel solutions have to fit in with societal, environmental and economic contexts. Moreover, they have to be robust to meet future uncertainties. E-learning has the capability to deliver these novel design solutions. We have developed a teaching method with this purpose in mind.

The success of any course delivery is the practical translation of the competences mentioned by the UNESCO learning for the twenty-first century [1]: knowledge, design methods, internalization of values and communication with all relevant stakeholders.

The authors of the present article investigated the effectiveness of two forms of workshops:

(i) in a class delivered course with an integrated workshop where stakeholders are all present and

(ii) through an e-learning delivered course with workshops targeted to specific stakeholders.

Student feedback scores show no significant preference for either of the forms. With these and other evaluation results, the authors conclude that effective, challenging courses require a 360° and regular feedback, which is pivotal for increased student satisfaction.

Keywords: Environmental course, e-learning, Stakeholders, Feedback, Life Cycle Analysis.

1 INTRODUCTION

In their course design, most Universities nowadays have to oversee and apply sustainability additionally to the technical specifications [2]. Directed by stakeholder requirements, an environmental course design introduces assessments on social acceptance and longer term scenarios on resources and on emission restrictions. From the perspective of education: sustainability requires new competences of environmental related skills, additional to the traditional focus on resources balances, and on cost. Sustainability requires practitioners to develop insight into the broad implications of their decisions for the long term, and from the perspective of the society, environment and business. This paper looks comparatively at teaching methods to educate these sustainability related competences for environmental courses.

Both in a professional and educational setting, a key aspect of sustainability is to apply an integrated approach, constituted as the combined contribution of social, environmental and economic requirements of the course design [3]. This integrated approach generally is viewed as a challenge in environmental courses, because it only works if all three contributing aspects are properly addressed [4].

Of the economy, ecology, and social aspects on sustainability, the social aspect is an equally important factor [5], but it is reported to be underestimated in education on sustainability [6]. The reason is that the environmental and economic aspects of sustainability are relatively easy to teach [7], but academics in environmental disciplines have difficulty to address the factor concerning the social aspects of a design and its embedding in societal trends [7].

This paper looks at two practices on education in which postgraduate students within a relatively short period (1 module is 5 ECTS points; European Credit Transfer System) apply an integrated approach in

making a sustainable decision within a environmental related problem solving context. Required competences situated within a theoretical framework on sustainability are developed and discussed. Based on recent literature trends, we found out that involving representatives of stakeholders is a very useful and effective way to teach sustainability [8]. As interactive education is strongly recommended [3], we show that workshops with these stakeholders are an efficient form of education for this type of courses. Finally the students' evaluations of our courses are reviewed, based on various editions of the courses, leading to general recommendations for lecturers who aim to effectively teach sustainability in the environmental courses.

2   FOUR COMPETENCES

Developing courses start with defining learning outcomes, usually in terms of competences, for which we roughly follow the four learning pillars [2] proposed for education in the 21th century. These 'pillars' shortly are: 1) learning to know, 2) learning to do, 3) learning to be and 4) learning to live together, or also stated as knowledge, methodological, personal and social learning respectively [1]. The four pillars are the best base to define our key competences as they are generally accepted and, as we show below, provide a good starting point to define key competences fully covering the field of sustainability:

> a. Sustainability competence ('Learning to know', or 'Knowledge') in jobs and future career. With sustainability we mean the development of a long term view on sustainability, including equity, resource depletion, climate change, biodiversity, and security of the supply of energy. The student is made aware that having the lead means also to evaluate the technological implications of choices on environment regarding the sustainability decision [4].

> b. Ability to 'Learning how to'. This means the capability to optimize solutions in terms of sustainability using appropriate teaching tools for the environmental aspects (LCA), the long term aspects (Scenarios) and the social aspects (stakeholder panel discussions). We concentrate on tools which can be directly linked to the three main areas of sustainability (environmental, economic and social). Especially linked to the social and economic area, an important skill is to be able to develop a long term view, as sustainability is strongly connected with future (generations) development [9].

Nowadays, environment is strongly connected to the usage of raw materials and energy, the possibilities of reuse and so to reduce emissions to the environment and depletion of scarce resources. A well-known tool is Life Cycle Assessment (LCA) that not only systematically structures the material and energy flows in the system under investigation, but also is a way to evaluate consequences of decisions in development planning and implementation [8]. Summarized, three key mechanisms in making a sustainable decision are:

1. Life Cycle Assessment is the monitoring and designing of the material and energy flow, related to resources;
2. Building sets of scenarios focuses on the social and economic long term view;
3. Stakeholder panel evaluation.

LCA directly focuses on resources and emissions and the possibility of recycling, which is of great value to the present society, as designs usually involve large material and energy flows from and to the environment. Furthermore, a key aspect of sustainability is a long term view for which building sets of scenarios are very useful.

> c. 'Learning to be' competence. This competence connects sustainability to the choices of the decision makers, as a person, or as teams. It can be regarded as a specification of attitude [6]. The social sustainability part is related to this third key competence. In our courses modules this competence is acquired through making a personal statement (sustainability declaration) and through making assessments related to a specific assignments. The field of assessment involves and represents the uncertainties mentioned before, because one of the main features of sustainable solutions is that requirements and specifications cannot be stated as fixed but may be viewed as a dynamic process [10]. As environmental practitioners are mainly taught to work dealing with uncertainties this can therefore be looked upon as an additional competence [11]. This third competence infers that all practitioners should develop the ability to make a well balanced assessment, in a professional setting.

d. Innovative competence ('Learning to live' or 'Social').   The practitioner has to propose solutions that meet all sustainability goals and constraints. This means in general that the approach is novel and often haa a break-through character. It also has to be technically and economically feasible. This means that the student has to acquire knowledge about the innovation process, i.e. the steps needed from idea to commercial implementation, see e.g. [12]. Also from an education point of view, the student learns to think in an innovative radical way, as this is often needed to find sustainable solutions for the long term [13].

In acquiring the four competences, the three factors of sustainability, social, economic, and environment, all should be simultaneously addressed.

Table 1. Features of environmental MSc course.

Competences	Stakeholder Role	Workshop as a tool	Stakeholders participation	Stakeholders case studies
Sustainability competence	show practical applications of implementing sustainability	Provide feedback to students	real experience on implementing sustainability for students conclusion	stakeholder real case scenario provided
Learning how to	advise on scenarios and LCA choices: key parameters	group work based on discussions	Students propose LCA to stakeholders	stakeholder advise on LCA and strategy
Learning to be	representative stakeholders	assessment derived from debating solutions	student versus stakeholders solutions debate	Public fora discussion on practicality of proposed solution
Innovative competence	real case scenarios	Technical against useful	stakeholders feedback on students final solution	stakeholders final verdict on solution choice

3   EVALUATION OF COURSE FORMS

Our past experiences in teaching Sustainability are based on many years experiences with Master and PhD courses. The purpose of the course is to learn to design processes, products and systems with sustainable development goals and constraints. The case is composed and introduced by an industrial representative as stakeholder (e.g. company, association, community, etc) that has sustainable development goals in its strategy.

At the end of the course the student proposed solution for the case are presented to the problem owner and to others forming the user group. In this way, the results of the case are immediately tested and compared with practical application in an in-situ setting. The involvement of a stakeholder highly motivates the students to deliver an excellent solution resulting in a view of all three sustainable developmental aspects.

The master courses on *Environmental Security*, *Green Technology* and *Sustainable and Ecological Tourism* are supported by a consortium of 7 European Universities and 10 companies and associations and is based on partnership course development and delivery. Students learn and practice in how to personally assess what and how they can contribute to sustainable management and development of sustainable Europe. The stakeholders participate as guest lecturers to eight colloquiums in specific aspects of sustainability. The technically oriented case is group project work, to develop and practice solution design as well as balanced assessment methods. Representatives of the stakeholders give a broad view on the complexity of sustainability issues

As has been pointed out in the introduction, the course leader summarizes their experiences with teaching these courses in terms of the role of the stakeholder and the role of a workshop in the learning process, because these two aspects reflect their main experiences in teaching

sustainable development in a sustainability setting. Table 1 summarizes the main features of these courses, concerning these topics, which will be the starting point for section 4.

4   EXPERIENCES IN DEVELOPING EFFECTIVE TEACHING METHODS

Teaching sustainability to students is a combination of effectively providing feedback and incorporating stakeholders as active contributors. Starting with the latter point, for the participants, stakeholders introduce an unusually new or unexpected view on sustainability. Participants of the course learn from the different views of the stakeholders' contributions illustrating the complexity of sustainability issues incorporating long term views on resources combined with market behaviours in combination with governmental regulations.

One of the items in these courses is the amount of feedback by the external contributors, generally stated to all groups, or more specified per individual group. The way of providing feedback and the time spent on feedback are concurrent. Feedback per group usually is time consuming and therefore we found it better to have specified feedback on groups results. Usually we ask the groups to briskly present their results on which we (and guest lecturers) provide feedback. However, the time of giving feedback should be restricted, to keep all groups attached to the topics covered. From the many workshops we have provided, we concluded that the time spent to a lecture and to group work should be approximately equally divided. A lot of time directed to a lecture will provide a lot of information, which only is effective when applied in group work to a case. A rule of thumb is to spend 50% on lectures and 50% on group work (and feedback) and this works well.

We also have found that the workshop is most effective when students prepare the workshop with an assignment. The workshop leader gives feedback on their work and adds specific information on the topic covered and on the application of sustainability in general. In this respect, students are right from the start being involved in the workshop, which enhances the learning process.

Table 2. Evaluating workshops delivery (independent and joint) and two forms of applying theoretical knowledge on case studies (assignments per workshop or a central case). Scale is between 1 (very negative) to 5 (very positive).

	Independent workshops and case studies	Joint workshops and case studies	Assignments per group
Characteristics	Topic introduction, group work and conclusion	Clear topic outcomes expected	Case studies on specific topics
Work load	Daily course	1/2 day colloquium and 1/2 day group work	1/2 day assignment work
Elements	Colloquium, group work and reporting	Lecture, group reading	Design of cases for specific topic
Benefits	Clear structure with a workshop decision	Effective form of education	Optimally design for topic
Important element	One day not enough	Reduced coaching time	Sustainability cascaded across topics
Challenges	Interesting subject	Clear Instructions on deliverables	Cases embedded in real cases
Evaluation	Average score 3,7	Average score 3.5	Average score 3.3

Originally the set-up of courses was based upon topics but we gradually changed this so it related more to competences and stakeholders. The reason for this modification is that the main objective of workshops is on educational competences, as they are related to the learning goals of the courses, rather than handling specific topics.

Finally, as Table 2 shows, each different form has its benefits, points to pay attention to, and challenges. Throughout the years, we have applied all variations of Table 2 in our courses design and

implementation, depending on results of students' evaluations, new insights, but also on local circumstances as the number of representatives of stakeholders involved in courses and their time available. In some cases, the form of workshops was partly depending on the time schedule of students, regarding other courses running parallel. We also have varied with the position of cases in the courses, either cases as exercises of each topic, or a large case which functions as a continuing project during the course.

5   CONCLUSIONS

In developing effective teaching methods for environmental based courses, four key competences form a solid foundation to build a course on:

- a.   Sustainability competence,
- b.   Learning how to,
- c.   Learning to be, and
- d.   Innovative competence.

Courses on Masters level provided data on the role of stakeholders and on the application of a workshop setting. Experiences from the courses show the importance of an adequate feedback, the effectiveness of workshop preparation by group work and the positive influence of representatives of stakeholders in reflecting on the students work.

Finally, students did not show a preference of a specific type of workshop, e.g., a workshop in which a central case is applied was not preferred above a set of workshops each having a small case. However, we have summarized experiences which may help lecturers to effectively set-up dedicated teaching courses on sustainable development for practitioners.

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