Sustainable Development in Nano-Perspectives – An Innovative Student Initiative

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***Abstract*—This paper describes and discusses a novel class for sustainable development at the Faculty of Engineering at Lund University, Sweden. Based on personal experience and student questionnaires, the study discusses applied pedagogical approaches and suggests improvements to the structure of the class. The project is a student initiative, making student involvement and its effects on learning for sustainable development central topics of this paper, thereby challenging the notion of engineering students as passive receivers of education for sustainable development.**

***Index Terms*—Student Initiative, Sustainability, Teaching**

I. Introduction

With sustainable development being one of the most important and most discussed topics of the time, education for sustainable development (ESD) is a fast growing discipline [1]. In Europe, the restructuring of higher education programs in the wake of the Bologna reform [2] has offered valuable opportunities for higher education institutions to introduce ESD into program curricula [3]. However, ambitions vary greatly among the different universities.

Recognizing the special challenge (and importance) of introducing ESD into engineering education [3], we have developed a class based on nontraditional teaching methodologies [1,5,6]. The class "Sustainable Development in Nano-Perspectives" is based on a case study in combination with role play activities [7]. Students represent a variety of societal stakeholder groups while trying to create a roadmap for sustainable development for a given case project. The class is structured according to a "matrix" approach with stakeholder groups and interdisciplinary groups. By interaction within the different groups, students are forced to shift perspectives [6]. In an iterative process, culminating in a 24-hour general meeting, the groups negotiate a common roadmap for sustainable development (SD) in relation to the case they were given to study. Directly thereafter, the students defend their work at a simulated press-conference. All activities are mandatory.

With this class structure, the authors are hoping to "train the students in critically reflecting about their role within and their influence on the society in which they are active, and to thus enable them to work for a sustainable development" [7]. This process is often called "transformative learning" in ESD literature [8,9].

Our experiences with above described approaches are fundamentally positive. Still, we have learned a number of important lessons. These lessons concern mainly how to facilitate a shift of perspectives without creating too much frustration, the importance of clarity and motivation, as well as the effects of student involvement.

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II. Methods

The nature of this study is mainly conceptual: The authors' experiences while teaching the class are described, and qualitative data obtained directly afterwards is used to offer valuable insight for those who might be interested in applying similar pedagogical approaches.

Subjective insights are here combined with more objective data from the Course Experience Questionnaire (CEQ), a standardized, anonymous evaluation after the completion of each class [10], from a written (anonymous) feedback, and an oral (non-anonymous) feedback.

III. Perspective Shift without Frustration

According to many scholars of ESD, conflicts, pluralism of thought [9], and even "disorienting dilemmas" [8] are prerequisites for higher learning and ESD. Scholars also seem to agree that the most important lessons for students to learn are generic skills, attitudes and values, because sustainability is seen as a "social learning process rather than as expert predetermined and teachable products" [9]. For achieving this ambitious goal, new pedagogical approaches, such as those applied for the class described here are embraced and supported within the ESD community [4,5,6,8]. Even the students express this in the written course evaluation. The students also mentioned that this active form of education has improved their learning. At the oral feedback session, more than half of the students also mentioned feeling excitement, expectation and curiosity throughout the duration of the class.

Nevertheless, the authors have experienced difficulties in encouraging students to focus on SD. As the students were confronted with entirely new subjects, new methods and new ways of thinking, they were thrown out of their intellectual comfort zone and instinctively tried to hold on to anything familiar to them. Continuous reminders to focus on SD rather the case finally set the students on the right track, yet leaving many of them feeling frustrated with the teachers' feedback throughout the course. While part of this frustration and unsettling experience may be necessary for "help[ing to] construct the self concept of the student as a life long learner" [1], it could have been alleviated by introducing the different elements of the class in stages, preferably in the following order: 1) SD, 2) stakeholder groups, 3) the case. While decreasing their level of frustration, a staggered introduction of the class elements would most certainly have led to an increased level

of conflict within the case itself, and thus better discussions in the inter-group meetings. The setup would also have allowed the students to relate to SD from many different perspectives: first their own perspective, later their stakeholder groups' perspective, and last but not least in relation to the case.

Ideally, the students would have been confronted with SD during classes taught at an earlier stage in their curriculum. A gradual introduction of the subject matter throughout the entire educational program would facilitate for both teachers and learners. Ultimately, we promote the integration of SD into all classes taught within the program of Engineering Nanoscience, and into all curricula taught at LTH.

IV. The Importance of Clarity and Motivation

As discussed above, most students report a successful learning experience. Yet, there is a large percentage of students who are dissatisfied with the class as a whole. Students requested clearer instructions about what is expected from them to do well in the class. And despite the fact that they were given constant feedback on their work, they felt unassured about their own performance. Partly, this is due to the unfamiliarity of the subject. This is in agreement with a study by Lundholm [11]. For students of engineering, who are used to a culture in which there is a right and a wrong answer, it may be difficult to accept that it is attitudes and values which they have to practice rather than pure subject matter. Teachers should be very clear about what the important challenges are and which kind of learning they expect from their students.

Another challenge for learners of ESD is a perceived irrelevance of the subject for their future profession. "Students do not see how the courses in environment and SD are relevant for their education" [5]. In order to improve learning (and student satisfaction), it is therefore of utmost importance to put considerable effort into communicating both learning outcomes [1] and relevance for the profession of engineers. Only if students understand why the subject is important and how they can apply the lessons learned, will they be able to become active agents for change. Thus communication is crucial for achieving transformative learning.

V. Effects of Students Involvement

Student involvement is an integral part of this project. Two kinds of student involvement are implemented: a) the class is based on a student initiative, with active participation of students in creating and designing the class, and b) students who are enrolled in the class are given extensive responsibilities to influence their learning experience.

This project would not have been feasible without the devoted effort which the student authors of this paper have put into motivating and creating the class. Despite their relative lack of experience in teaching and pedagogy, their involvement has been crucial for the success of the project.

In "Sustainable Development in Nano-Perspectives", a group of six enrolled students (the "organizational committee") was entrusted with the responsibility to organize the general meeting and the press-conference. The students were autonomous in all decisions concerning the structure of the meeting and were even responsible for managing the event. The authors' experience with this approach is that the students were extremely motivated and encouraged. Discussions and negotiations about the common road map continued until late at night without any pressure from the teachers.

But student involvement is crucial for another reason: It encourages students to become active agents for SD by "making the development of action and action competence an integral part of the learning process" [9]. Therefore, we believe that ESD depends on student involvement in all aspects of learning and teaching.

VI. Conclusions

We have presented a novel class in sustainability for students of Engineering Nanoscience at LTH. We have highlighted the importance of finding an appropriate level of disorientation for transformative learning without discouragement. We have also stressed the importance of clearly communicating and motivating course goals.

Despite the conceptual nature of this study, we believe that it carries a number of practical implications for colleges of engineering who wish to improve their teaching for sustainable development. We urge Lund University and LTH to establish ambitious guidelines for introducing ESD in individual classes as well as educational programs.

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