Introduction of Interdisciplinary Teaching: Two Case Studies

Commentary on "Teaching Science, Technology, and Society to Engineering Students: A Sixteen Year Journey"

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Abstract

Interdisciplinary courses on science, engineering and society have been successfully established in two cases, at Bilkent University, Ankara, Turkey, and at the University of Hamburg, Germany. In both cases there were institutional and perceptual barriers that had to be overcome in the primarily disciplinary departments. The ingredients of success included a clear vision of interdisciplinary themes and didactics, and the exploitation of institutional opportunities. Haldun M. Ozaktas in Ankara used the dynamics of an accreditation process to establish courses on engineering and society. At the University of Hamburg the introduction of optional courses into all curricula allowed for the establishment of a seminar series on physics and society, as well as on peace education and peace building. Both of these approaches have a weakness in common: the courses can disappear once their initiators have left, unless the interdisciplinary themes are integrated into compulsory core curricula.

Keywords

engineering ethics education; science, technology and society education;
interdisciplinary higher education; peace studies;

Introduction: The Case at Bilkent University

Students and teachers tend to identify with their own disciplines and to emphasize disciplinary thinking and the formation of disciplinary communities. Yet it is possible to engage engineering students successfully in an interdisciplinary teaching approach in classroom settings of 150 and even 500 students (Ozaktas 2012).

The essence of Ozaktas' paper is particularly intriguing. Haldun Ozaktas has chosen to teach science, technology and society in a separate dedicated course, instead of trying to convince the faculty to integrate the theme in regular engineering courses. This was his only choice as a pioneer in a difficult environment. His teaching focus is on current issues like alternative energy instead of broader reliance on the historical role of science and technology in society. He exposes students to different points of view from written material, guest speakers and interaction among students themselves, and he emphasizes a multidisciplinary *systemic* approach beyond traditional engineering ethics which tends to focus on *individual* ethical decisions.

Ozaktas has also successfully experimented with engaging students in community research projects. He has tasked groups of 8-12 students to propose and undertake research on a particular problem in a local community, such as public health or social issues. He observed an immense educational value through the involvement of students at an emotional and social level. This fostered creativity, individual and collective action, and reflection on the consequences of one's actions, both local and global. Unfortunately, this form of learning by field research and action had to be terminated due to a lack of staff resources. Project-oriented learning and teaching tends to need more staff resources and engagement than regular class

room teaching. It can only be institutionalized (after the initiators have left), if it is embraced and supported by the institution at large. There are successful examples of this, in particular at Aalborg University in Denmark which relies heavily on project-oriented learning and teaching (Kolmos et al.2007).

As Ozaktas points out, the five dimensions of learning and teaching styles set forth by Richard Felder and Linda Silverman (Felder and Silverman, 1988) needed to be adapted for his audience of engineering students:

- *Concrete and factual teaching material* is given priority over abstract-theoretical models and principles.
- Emphasis is on *visual input* (pictures, diagrams, video sequences, student appearance on stage), while still requesting *reading* of longer texts in preparation of students for class sessions.
- The *inductive approach*, starting with facts and observations, is used in order to catch students' interest and to allow for generalisations later.
- The focus is on *active learning* styles, like community research in small groups, debates on stage, and mass voting in large classroom settings.
- Both *sequential* (step by step) and *global* (holistic) teaching styles are employed.

The Case at the University of Hamburg

Since 1984 the present author [Hartwig Spitzer] has included discussion of the societal impacts of science both in regular physics courses and in dedicated seminars on physics and society within the physics department of Hamburg University (see: http://censis.informatik.uni-hamburg.de/ →Teaching [Accessed 13 September 2013]).

Recently he has also been involved in establishing interdisciplinary curricula on peace and conflict studies, and peace education at the university level (see: www.znf.uni-hamburg.de/Friedensbildung). The author has found students of physics and of the social sciences in Hamburg to be open to occasional deductive use of basic principles and concepts in contrast to Ozaktas' observations with his engineering students in Ankara. One example of a basic principle as used in Hamburg is the role of energy conservation both in physics and in the societal use of technology.

Students in Hamburg have been enthusiastic about audio-visual introductions to the theme of seminar sessions. They were tasked to select and present a ten-minute video film that illustrated the theme from a particular perspective, like a film on a non-war-faring tribe in a session on peaceful societies. Present day students seem to be very responsive to such "starters". The teaching program on peace education and peace building covers case studies of societal and international conflicts. It emphasizes ways of dealing with conflicts in a constructive way. It is mainly attended by students from the social sciences and the humanities, and only rarely by students from the natural sciences. In complement, the Carl Friedrich von Weizsäcker - Centre for Science and Peace Research offers courses on science and peace research, which are attended by students of the natural sciences and from other faculties as well (see www. znf.uni-hamburg.de →Lehre/Studium).

What Can Be Learned from the Ankara and Hamburg Experiences?

A successful introduction of interdisciplinary teaching on science, technology and society must overcome a number of challenges:

- *Developing a convincing curriculum and teaching style that engages students.*
- *Dealing with institutional boundaries and exploiting local opportunities*.

- *Involving colleagues*

Each university is a different “ecosystem” offering specific kinds of obstacles and opportunities. For example, Haldun Ozaktas was able to exploit an on-going accreditation process of his university to introduce his theme as a compulsory course. The establishment of compulsory courses on science, engineering and society should be the ultimate goal.

In Hamburg it was only possible to establish the relevant courses on an optional basis. Students of physics are required to subscribe to two seminars in order to acquire necessary presentation skills. This requirement opened the door for a regular seminar on physics and society. The theme was chosen by the instructors, not mandated by the department. Thus the theme could disappear once the particular instructors leave the university. For this reason efforts are needed to include the science and society theme in the core curriculum and to train teaching staff.

Haldun Ozaktas has been a pioneer. However, while successfully establishing a compulsory course in science, technology and society, he was unable to obtain additional support from his faculty and the University at large. Clearly he deserves an assignment of teaching assistants for group work. He would also benefit from the cooperation and collaboration of colleagues from the engineering faculty and from the social sciences.

In a favorable "top-down" process, university leadership will encourage or mandate interdisciplinary teaching and will allocate the required resources. In real life such support from the top is often missing or weak. What can be done through "bottom-up" approaches? The buzz word is networking and exploitation of all available niches in the system. It is easier

to implant an interdisciplinary teaching project in a highly discipline-oriented curriculum once the plan is initiated by several faculty members. When the author was asked by students in 1984 to sponsor a seminar on physics and the arms race, he agreed only after having convinced two colleagues to join him. Working in a small team makes one less vulnerable and more creative.

How can one recruit colleagues into such endeavors? Usually like-minded colleagues can be spotted easily. If there are none, it is reasonable to look for sympathetic and open colleagues who can be involved in stages. They can be invited initially to provide a guest lecture. As a next step, they can be offered an opportunity to co-teach a course in a setup where they cover the disciplinary aspects and you bring in the interdisciplinary knowledge and perspectives. This might be difficult when a high work load is involved, but it is still worthwhile to look for windows of opportunity.

At the University of Hamburg, the work load of students and teaching staff was significantly increased after introducing a strict and rigid bachelor-master system with "tons of exams", similar to engineering study programs. Still some students and faculty are open and even longing to go beyond the pure disciplinary teaching and learning focus. Once a network has started to teach interdisciplinary courses successfully, it builds a reputation and visibility which can support the next and necessary step: institutionalisation of the curriculum. Strategies and outcomes of such top-down and bottom-up approaches have been discussed at an international workshop "Teaching ethics and peace to science and engineering students" at University of Hamburg, 15-17 October, 2008. The workshop focused on three theme areas: it presented pioneering teaching initiatives from different European countries; it evaluated structural obstacles and strategies for the introduction of such teaching; and it formulated

recommendations. These recommendations included: 1) make teaching on science, engineering and society compulsory; 2) motivate the teaching staff; 3) use active learning forms; 4) provide external funding and guidelines. For more details see www.znf.uni-hamburg.de/ethics-and-peace.html (last visited 16 September, 2013).

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