

Importance of interdisciplinarity in education for sustainable development.

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Introduction

One only needs to read the newspaper every day, to see the world changing and evolving at an unprecedented rate. In our society the value of engineers has never been greater as they hold the key to keep the pace of technological innovation high enough to meet the needs of the present world. As European students, future engineers and members of the Board of European Students of Technology (BEST) we recognise this role and feel responsible toward society to keep technical education sustainable, taking in consideration the needs that present challenges have.

We believe that sustainability, interdisciplinarity and students' input can lead to the improvement of current university curricula, consequently raising the quality of graduated engineers and the overall rate of technological innovation, all of which will be very beneficial to society. Engineering programs need to incorporate the above elements in a more considerate way and thus reach a new level of sustainable growth in technical education.

The information contained in this paper is based on the opinions of a diverse group of European students, obtained during the Events on Education (EoE) coordinated by BEST. The precedent events can be considered as forums structured with workshops and outcome-oriented discussions. The main core is constituted by students, whilst input and background is shared by representatives of the institutional and corporate world. Their synergy is facilitated by the Educational Committee of BEST, on behalf of BEST and all events follow a unique theme. Conclusions for this paper will be drawn from BEST EoE - Education for Sustainable Development: Fostering the Revolution of Society, Vienna 2012 [2] that was conducted in cooperation with the Austrian UNESCO Commission, the European Society of Engineering Education. The importance of interdisciplinarity in Engineering Education was evaluated, the curricula of engineering students were assessed and examples of good practices were shared.

As European students, we feel that we have to contribute with our opinions and inputs to help design the future higher education programs. Since the first-hand-experience of students can be a major factor in shaping the formation of future engineering studies, BEST is an organisation that constantly strives to bring their opinion into the spotlight. Towards this direction the following paper is presented and summarises a list of recommendations for the sustainable development of Engineering Education.

The remainder of this paper is structured as follows: Section 1 will introduce the concept of sustainability while Section 2 will deal with interdisciplinarity/multidisciplinarity. A conclusion will then summarise the outcomes of the paper.

1. Sustainability in Higher Education - A key to the development of society.

1.1. Addressing current situation.

There are many forms and definitions of sustainability, but the most common one is strongly connected to ecology and environment. However there is a lot more to this topic. In simple words, sustainability is the capacity to endure. What exactly has to be upheld depends on the field we are looking at. The following key-areas were identified as elements of important impact on the growth of society and were elaborated separately and in accordance during EoE Vienna 2012 as shown in *Fig. 1*.

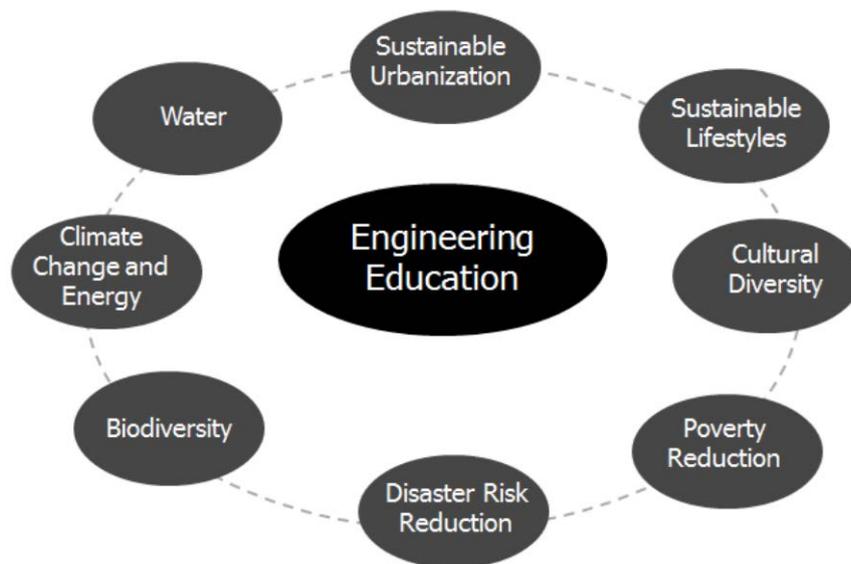


Fig. 1. Key-areas of EoE Vienna 2012

In our everyday life we're affecting and are affected by the surroundings. What we do, how we do it and where we do it is of great importance. In most of the cases we don't think about how our actions affect others and definitely not about the long term effects. In order to have a sustainable development in our society, we have to look far ahead in time. If we take urbanisation as an example, it is important for students and the public to become aware and feel part of it. This implies being proactive in creating tools that will enable us to create the mindsets that will lead to smart decisions. Everyone in society needs to realise the consequences of their actions and how they affect sustainability of urbanisation. Understanding systems and life cycles is essential in order to promote and gain sustainable lifestyles. In a globalised world where different cultures meet, society should be aware that cultural diversity provides a great potential resource for viable development and innovation. Reducing poverty is one of the ultimate aims of humankind and of course sustainable development of society has to strive towards this. Also there is one more area that can be improved in order to achieve a more sustainable society: risk reduction. According to students' opinions the major problem in risk reduction education is that it is only ever being done in theory. Students who do not have any practical experience cannot perform it when it is needed. And being unable to act in crisis situations is a major shortcoming that might hinder our advancement to a better lifestyle.

So far we have been focusing on aspects of sustainability that closely relate to society, lifestyle and our own actions. But as mentioned before there is more to this. During the symposium we also discussed topics related to ecology and environment. First of all society should have a responsibility towards these, and we should strive to continuously increase our knowledge about them, starting in childhood and increasing throughout later studies. Secondly, nature has inspired many inventions and students should be aware of them, in order to find creative ideas for engineering issues. Thirdly, many species are endangered and one of the main tasks for new engineers is to find an answer to the question of how technology can help to save biodiversity and provide successful sustainability. Moreover, awareness of issues related to climate change,

energy and water shortage should be raised. Lastly, areas of water management, like disaster prevention, evacuation, knowledge of local and global risks and resources have to be emphasised to our society, and we must be proactive about issues that might occur.

1.2. Recommendations.

Discussions amongst students and workshops held by experts resulted in many suggestions on how these problems could be solved. Although the topics that were discussed might seem quite different, the ideas that were proposed can be grouped into several categories.

A. First of all, making universities more accessible to the public and other external bodies. For instance, organising open days at the university and inviting speakers and guests from other universities, NGOs and business sector would not only enhance cultural diversity but also the sharing of knowledge and experiences.

B. The educational system should provide an awareness of the benefits of cultural diversity to students, and increase their understanding of different cultures. This will help to share knowledge from people with different backgrounds, in order to lead society to empowered diversity.

C. Moreover, the problem of poverty reduction can be addressed throughout such events. Exchanging experts and students (and at the same time knowledge) between universities would improve the average level of the quality of education. By mobilising professors, knowledge will spread to more countries and help them create sustainable standards. Free education or delivering financial support to students with limited financial possibilities, will help the societies grow by giving access to education to a wider part of the population.

D. Cooperation with different partners is crucial if we want to establish a dialogue with the rest of society and achieve our goals. Also, a closer cooperation between universities and companies is needed. Most of the students are lacking practical experience, what shows in many cases, like risk management or urbanisation. Having practical trainings on the topic will help in understanding problems society is facing and in creating solutions for them. For engineers, practical learning and collaboration with external bodies could help students look at things from different points, increasing networking and cooperation options in long term development. Field trips will raise students' awareness of the consequences of their actions towards nature and will help to prevent irresponsible and inconsiderate treatment to ecosystem in future. Not only that, but working on projects that involve real life cases will also give them a better understanding of the working methods and direction of the constantly ongoing development.

E. Another thing is involving students in improving their curricula. This can be done by tightening the cooperation between students and universities or by encouraging students to take courses provided by external bodies, which aren't taught at university, yet are relevant for them as future engineers.

F. Lack of humanity lectures, nature courses, real life examples and business related courses is a major shortcoming in previously discussed fields. Universities and educational institutions should strive to break down the barriers that make their knowledge inaccessible to the general public, and instead involve their surrounding communities, so they can work together towards a knowledge-based society.

2. Interdisciplinarity/Multidisciplinarity as vital elements of Engineering Education

2.1. Addressing current situation.

High interdisciplinarity and diverse activities in study offers are, according to reached students, key features of good engineering education and consequently of sustainability and development of society. There is a strong demand for interdisciplinary courses at universities and students feel responsible to make it happen. The first and most important step is raising awareness of curricula, it should make students aware of how their field of study affects the environment and the society. Technology studies need to be more connected to social studies, there should be a broad course catalogue with courses on humanities, e.g. economics, philosophy, languages, sociology, social skills etc. that they can learn to assess the impact and the effects of their activity on society and the environment. Also virtual education should be further developed and encouraged in courses, since it will often be the way of working during their careers. At the same time, lectures should include teamwork, projects and collaboration of students with different backgrounds, in an interdisciplinary, multidisciplinary and intercultural approach. Another interesting aspect to take into account is cooperation with students of different ages and not only with students of different fields of studies. This way stereotypes and prejudices could be reduced.

Following the line of developing students, a wide range of extracurricular events could be provided (for free if possible) at universities as well as promoting more efficiently the ones already existing, e.g. competitions and workshops. These courses should all give an overview of sustainable development and give the possibility to deepen the knowledge on certain aspects and topics.

The issue of broad versus deep knowledge arises regarding Education for Sustainable Development. One solution would be to give students a general overview on their studies but specialize only in a certain topic. It is believed by students that a mindset open to different aspects of thinking plays a major role here, e.g. specialists of different fields being able to cooperate. Nevertheless, both generalists and specialists are needed. Education systems and curricula need to reflect on these needs and its requirements.

2.2. Recommendations.

In the following section we'll go deeper into issue areas that were addressed earlier in this paper and suggest possible solution and improvement points gathered during the BEST Event on Education.

A. When talking about development of student curricula, several subjects were mentioned that could be of interest for future engineers but that aren't taught at many universities such as Waste Management, Transport, Water and Sewage Management, Air Pollution, Energy Efficiency and Consumption are examples of subjects to be included in technology studies to raise awareness about Sustainable Urbanization. This is important because students and public should become aware that they are part of Sustainable Urbanization and not outsiders. Moreover, it was also mentioned that this topic needs to be promoted as an investment root, rather than as an expenditure, as many people believe.

B. Lectures with different subjects such as economics and social science should become compulsory for engineers. More than in other fields, technical students should have a broad overview to understand the issues of Sustainable Lifestyles. Thinking in terms of systems and life cycles is essential and must be taught at universities.

C. Lectures or seminars on economics, politics and environment related to poverty reduction for engineering students could trigger the development of new technologies addressing the problems of developing countries. Also public speeches and debates

could be organised at universities to discuss poverty reduction issues, e.g. the issue of access to clean water and solutions for it.

D. Multidisciplinary courses for all engineers are highly appreciated by students, thus dealing with emergencies and risks would be an enriching one. When educating students about Disaster Risk Reduction, it has to be taken into account that it is not only about engineering, but also society and economy play a huge role in this field.

Education about Disaster Risk Reduction could happen implicitly or in a dedicated course integrated in the curricula of every field of study containing Risk Management skills. Students should also be educated on how to behave in case of a disaster.

E. About environment oriented topics, students should not only be aware of advantages of green energy, but also about the disadvantages. With that purpose in mind, lectures and seminars about climate change and energy efficiency should be held at universities open for public. This could be done by e.g. "summer universities" or two week classes on a specific topic. Although it exists in considerable quantities on Earth, it is a fact that consumable water is a limited resource. Consequently, people responsible for the future society should currently play a bigger role to preserve the most important resource in our world. To trigger students attention on this topic, proper subjects such as Water Management, Irrigation, Drinkable Water, Water Consumption and Water Supplies, including the economical and ecological point of view, should be implemented in higher engineering education curricula. Relating the previous fields with real life examples with real examples from the business world, case studies and site visits would increase students' awareness on this issue.

F. Universities are one of the most important institutional bodies to enhance the importance of sustainability in education. Therefore including the public more in their day-to-day activities such as workshops, was one of the students' suggestions for Universities to play a bigger role on this issue.

G. In case of urbanization, interdisciplinarity projects on city planning should be a vital part of the curricula of different study programs. Students would have an opportunity for interdisciplinarity work which could be further implemented in the city. Infrastructure designed for Sustainable Urbanization needs to be developed, and European (technical) universities could be leaders in this field.

H. According to student needs, cultural diversity should also be included in interdisciplinary programs, namely fostering exchange programs not only for students, but also for professors, in order to teach and research. Although the number of mobility programs is increasing every year, universities should make a bigger effort to encourage students to spend (at least) one semester in a foreign country. Also, it must be ensured that this would be affordable for every student, independently of their economical situation. Universities could directly cooperate with medium or small sized cities in order to make the city more energy efficient. This can be done by students working on real-life projects as a part of curricula, or through internships. Cities would benefit from those projects in a sense of better ecological and more efficient energy situation. This would consequently contribute to higher autonomy, better living conditions and an improved image of the city, which might even be presented as a tourist selling point, e.g., Zermatt.

I. Given that students are becoming more aware of the issues related to biodiversity, it is expected to bring a beneficial impact on humankind. One suggested way to deliver this topic in a way that really impacts students' awareness, was to show them some bad examples of economical and social decisions, and which consequences these had in our ecosystem.

Experiences for students where they face real case projects and experience interdisciplinary approach would have positive impact on education and universities. Focusing on the practical side of studies, there are some interesting activities such as workshops on designing useful assets by reusing materials which would allow different fields of study work together. The diversity of actions would raise awareness of students and public. Moreover, cooperation with external bodies, like companies and NGOs, should become an integral part of education. Cooperation with these bodies should also be recognised and students work accredited.

2.3. Developing an interdisciplinary in MSc.

Towards the direction to enhance interdisciplinarity in Engineering Education, an example of great interest is the ESTIA Earth Project with aim: "To Sustain the Women's Careers as Academics, Researchers and Professionals in Engineering, Computers and Sciences". [5] This project was coordinated by the National Technical University of Athens, Greece. One of the project's main purposes was to provide structured opportunities on education to women of different age and origin and to support their career development. The project was highly connected with Interdisciplinarity/Multidisciplinarity, as visible in the academical approach which will be described later on. Despite the fact that the project was designed to be women-friendly, and tried to solve problems that women scientists are facing in different stages of their life regarding their career, the project treated men and women in an equal way, in terms of the opportunities of participation given.

In the process of enhancing Interdisciplinarity, ESTIA Earth Project identified the current opportunities for interdisciplinary and multidisciplinary postgraduate degree courses among the partner universities. To continue with, an MSc Program curriculum was designed according to the aforementioned courses and is in final development. All courses are interdisciplinary/ multidisciplinary based, and meant to support lifelong education and learning for women, and are equally accessible by men. Following the concept of Interdisciplinarity/ Multidisciplinarity, the MSc was structured in a way that allows students to develop on the fields that they are interested in, flexible enough to choose among different courses and among the different universities according to their needs and background. The program is structured and based on four scientific Thematic Areas (Energy- Life, Management-Business, Computers – Informatics, Gender – Society) and the fifth one is dedicated to enhancing the specialization. [6]

Another example is CDIO project [7] implemented at the Telecommunications School (ETSETB) at UPC, Barcelona.[8] The CDIO (Conceive, Design, Implement and Operate) initiative was initiated by MIT and Universities Chalmers and KTH in Sweden to improve the experimental skills of engineering studies. More than 40 institutions are involved in this initiative. This approach was adopted and implemented together with Bologna process in 2009. During their studies, students face 4 projects, one in each year of their degree:

- Introduction to ICT engineering, ENTIC
- Basic Engineering Project, PBE,
- Advanced Engineering Project, PAE,
- Degree End Project,

CDIO believes that the proper context for learning engineering is to develop formative activities that imitate professional engineering practice. It defines a list of skills and standards to ensure their acquisition. In practice, this has been articulated in ETSETB, building an integrated and curriculum that uses a mixed formula. On one hand, the skills are woven into the subjects, which incorporate specific training activities. On another hand, curricula include project subjects where students conceive, design, implement and operate complex ICT systems by working in team. In short, CDIO links the generic skills to the context of engineering learning, and aims to provide experiences that ensure the development of these skills in a natural way. Moreover, this method allows integrating and extending knowledge learnt on other subjects by facing the design and implementation phases of a given project.

Conclusion

In today's society, it is fundamental to help Higher Engineering Education evolve to face new challenges that are arising every day. During BEST Event on Education in Vienna, sustainability, interdisciplinarity and multidisciplinary were identified as some of the major fields on which university curricula could improve. Improving these aspects will bring to society the desired Higher Engineering Education to support the next generations.

Discussions about sustainability were able to define its role in the curricula of an engineer and resulted in a list of proposals to raise awareness of the topic not only to students but to the general population as well. It is widely accepted that sustainability starts only after people realise what it is and what impact they have on the world around themselves.

Further discussions highlighted the necessity to introduce more interdisciplinarity and multidisciplinary in present technical education. As engineers are a vital part of society, it is important that they realise their role not only in the technological field but in every other fields as well. To satisfy that need students themselves wrote a list of suggestions to improve this, such as the implementation and improvement of virtual education and raising the number of lectures about humanities. As a positive example of the implementation of interdisciplinarity we mentioned the ESTIA Earth Project and CDIO project.

Technical students need to understand that their actions do not influence only their neighbour but the rest of society as well. They also need to understand that, even if they already have a great impact on society, with the right background, they can influence it even more. Introducing sustainability, interdisciplinarity and multidisciplinary in engineering education is one of the ways we can raise awareness in future engineers about their role in the world and what they can do to improve it.

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