Integrated Project with Focus on Energy Transition and Circular Economy for Developing Engineering Students' Soft Skills

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Abstract

The present work reports the experience of an integrated project developed at the University of Liege for master students in chemical engineering. The goals are to promote the acquisition of soft skills and to consolidate technical knowledge by integrating and linking chemical engineering disciplines usually taught separately. A case study was selected to address some of the challenges related to energy transition: students had to design the energy system of a remote island and make it as energy independent and CO_2-neutral as possible by 2030. The course of action during the academic year, the assessment of soft skills, and the tools offered to ease the mentoring and encourage the acquisition of soft skills are described. Not all implemented techniques performed equally well, and this project finally appeared to be a challenge for the teaching team as well.

1 Introduction and background

Over the last few years, University authorities, industrial partners as well as national and international experts that evaluated the education quality of our Department (AEQES, CTI) strongly suggested that opportunities should be offered to students to increase their soft skills as part of their curriculum. Moreover, many developments in chemical engineering are related to energy transition and circular economy, which are both transdisciplinary to conventional lectures. In this paper, we present methods and mentoring tools developed to teach students technical and soft skills for multi-disciplinary topics.

2 Description of the integrated project

Objectives and constraints were defined at the onset of the project for both technical and soft skills. The technical objective was to propose an energy system that would make Reunion Island as energy independent and CO_2-neutral as possible by 2030. This idea originated in the challenge set by the Eurecha 2015 student contest[1], for which students had to design facilities for a sheikhdom: electricity, water recycling, production of fertilizers… In our case, Reunion Island (~850 000 inhabitants) was considered as a case study as it is remote, has large biomass resources and high potential for renewable energies. Besides the objectives mentioned above and in order to force students to look at chemical engineering processes, the treatment of wastewater was imposed as well as the use of a synthetic liquid fuel as energy carrier. The targeted soft skills included working in large groups of minimum 4 students, efficient communication of results in English - both written and oral -, ability to integrate knowledge from various disciplines, development of critical mind and demonstration of independent and creative thinking.

3 Course of actions

A team of 8 professors and senior scientists mentored the project and contributed to its assessment. The 10-ECTS project was divided in two parts. In the fall semester, students made global energy balances to design the energy system that would fulfill the objectives. As a result, a Sankey diagram of the energy flows on Reunion Island by 2030 was produced to allow for an overview of the available Island's resources and needs, as well as of processes that can make the link between resources and needs. In the spring semester, two processes identified in the first part, namely the synthesis of bio-ethanol and bio-methanol, were modelled in more details using commercial software. Different tools were used to encourage student initiatives and work:

- The use of a **shared on-line portfolio** for students to gather their documents improved their internal communication, but this remained a marginal channel for communication with teachers
- In the fall semester, students **orally presented progress reports every two weeks**. After a feedback to students, the teaching team met to discuss the achievements and set the objectives for the next two weeks. This was very positive for the communication inside the teaching team. However, presentations every fortnight implied a work overload for students that had to constantly focus on preparing the presentations.
- From the beginning, students were strongly encouraged to **reach out to field experts** whose contacts were provided. However, they preferred to rely mostly on Internet as their main source of information and reached out only rarely for help and usually very late.
- In the fall semester, students had to designate **new team leaders in turn** every fortnight. This was abandoned as it prevented the establishment of clear structures in the group, reducing its efficiency.
- In the spring semester, **work tables** allowed students to work directly with the teacher specialized in their task. This was appreciated by students and teachers, and it needs to be further encouraged.
- **Help in the group organization and interactions** was provided by the PSGO (psychology of groups and organizations). This also included videoscopy, i.e. filming the students during their presentations and analyzing the records with them. This help was appreciated by students.

The assessment was based on **technical results for 60%,** and **soft skills for 40%.** The evaluation of technical skills was done partly by all teachers equally and partly by teachers whose expertise was the closest to the technical sub-tasks. For soft skills, efficient communication, creativity in the work and results and links with conventional lectures were assessed. Critical thinking was evaluated through the relevance of qualitative and quantitative results and discussions. Group work was assessed by the teachers as well as by students through mutual evaluation.

4 Conclusions and perspectives

The integrated project gave students a first opportunity to improve their soft skills along with their technical knowledge. It also improved their communication skills and their fluency in English. The teaching team proposed different mentoring techniques to encourage efficient work, with varying results. Finally, as the assessment ignored soft skills improvements, it may be modified by evaluating soft skills all year long so both the final result and the observed improvements contribute to the grade.

Reference

Eurecha, The European Committee for the Use of Computers in Chemical Engineering Education, 2015. Announcement for student contest problem competition 2015. http://bari.upc.es/eurecha/.