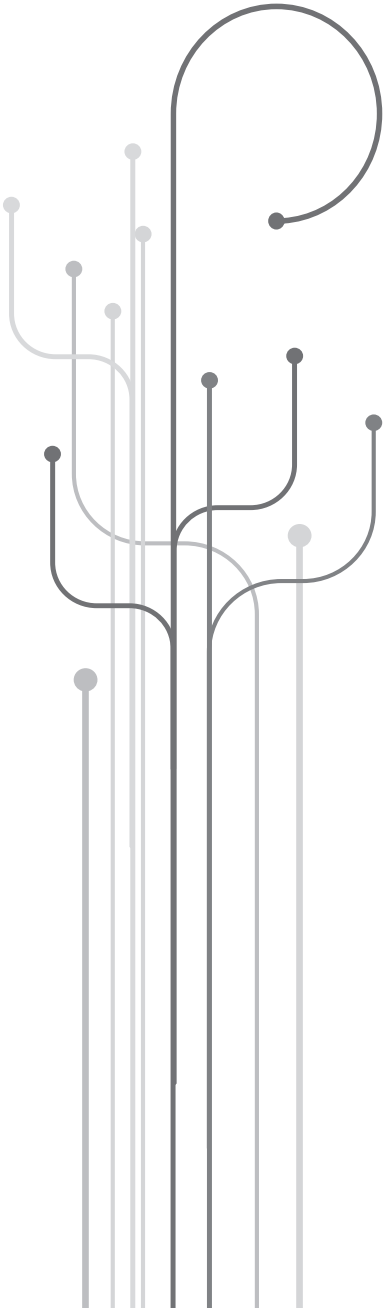

11th IPB Erasmus Week
Teaching Crossroads

Edited by

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Product Development and Industrial Processing

Joint IPB/EAL course

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Abstract

This article aims at presenting a teaching experiment where the same course is taught simultaneously in two countries, Portugal at the Polytechnic Institute of Bragança (IPB) and Denmark, at Lillebaelt Academy (EAL). Project Based Learning (PBL) underlies the applied methodology.

As the project is still in its initial phase it is too premature to delve into a conclusive and thus critical approach. Nonetheless, we will highlight the course

methodological procedures and objectives as well as the educational gains to the students and to the two institutions involved.

Keywords: ***teaching experiment, Project Based Learning, Product Development, Industrial Processing***

Introduction

Project Based Learning (PBL) is one of the most popular new teaching methodologies in the context of engineering teaching. Most of all engineering courses present some type of project evaluation at BSc or MSc levels. And several project configurations are possible while considering teamwork and project integration: having groups of students dedicated to a larger project where each one is concentrated into one specific issue; or having PhD students teaming up with MSc and BSc finalists are amongst common setups for obtaining synergies on applied research and teaching (supervising) goals. However, project courses are placed in the end of the student's journey and are considered, and evaluated, as a student's solo venture.

PBL methodology is being brought to the early phases of the engineering curricula, and in the case of the Lillebaelt Academy (EAL), it has been introduced into the very first semester of their engineering courses. Concurrently, at IPB, engineering courses based on PBL are rare and result from individual initiatives confined to 6 ECTS.

To identify and overcome the difficulties of implementation of a PBL based course in engineering, a 12 ECTS joint course from Lillebaelt Academy and Bragança Polytechnic Institute was created based on the Danish model: a 12 ECTS course named Product Development and Industrial Processing.

Project Based Learning methodology

Project Based Learning is a student-centred pedagogy in which students learn about a subject through the experience of solving an open-ended problem. Students learn both thinking strategies and domain knowledge. The PBL format originated from the medical school of thought, and is now used in other schools of thought too. It was developed at the McMaster University Medical School in Canada in the 1960s and has since spread around the world (Lee & Kwan, 1997, pp. 149-158). The goals of PBL are to help students develop flexible knowledge, effective problem solving skills, self-directed learning, effective collaboration skills and intrinsic motivation. Problem-based learning is a style of active learning (Felder & Silverman, 1988, pp. 674-681).

Working in groups, students identify what they already know, what they need to know, and how and where to access new information that may lead to the resolution of the problem. The role of the instructor (known as the tutor in PBL) is to facilitate learning by supporting, guiding, and monitoring the learning process.

The tutor must build students' confidence to take on the problem, and encourage the students, while also stretching their understanding. PBL represents a paradigm shift from traditional teaching and learning philosophy, which is more often lecture-based. The constructs for teaching PBL are very different from traditional classroom/lecture teaching.

The problem at hand

One of the most critical issues regarding PBL is the choice of the project. It should be open-ended, authentic (have a real-world context) and public. In this case the overall purpose of this project was to provide students with knowledge of composite materials, internal and external environmental conditions, apply innovation and development and production optimization in practice. It is based on recycling of plastic composites especially wind turbine blades.

The project is based on cradle-to-cradle philosophy, which is to produce products such that all are included in the closed biological and technical cycles - and thus completely disposed of waste.

The waste from plastic composites has different origins: old wind turbine blades, scrapped boats, train and automobile parts, trailers, waste containers, roof boxes, etc. Wastes from composite manufacturing contribute significantly.

This is a real problem that will increase over time. For instance, the amount of composite waste in Denmark was 7000 tons in 2010 (one third was manufacturing waste) and it is paid for depositing old windmill blades instead of recycling. More than 5000 Vestas wind turbines will be settled over the next 10 years and at global level, waste from wind turbine blades are estimated to 2.2 million tons in 2030 (Gill, 2012).

The economic potential of recycling of composites depends on:

- Technical solutions and opportunities;
- Regulatory requirements;
- Investment requirements for recycling facilities;
- Supply and demand of materials.

The Waste Directive (Directive 2008/98/EC) sets the framework for waste management. In Denmark there are no specific rules for waste management of composite materials although the EU Commission has announced that it will review existing targets to prevent, reuse, recover and recycling. Waste is a material related resource if composites are shredded and recycled. Figure 1 depicts the material from a shredded wind turbine blade that is being used in the Product Development and Industrial Processing course.

***Figure 1**: Straw like feature of a shredded wind turbine blade*

The problem was presented by a Danish factory to both schools being protected by a Non-Disclosure Agreement signed by the coordinators of the project in both countries.

The course structure

The basic structure of the course is presented by the scheme in table 1, were the semester is divided into 4 periods: 3 with 5 weeks and a last one with 2 weeks. By the end of each 5-week period a student has to present a report that that will be graded together with the final exam. The last period is dedicated to an "International Week", where the students will have to travel to other country, in this case Portugal, and cross-check their work with the local students.

The course was structured for 15+15 students from both institutions that would have to work simultaneous at the same project, and subprojects, in Denmark and in Portugal. Regular videoconference meetings would be held between Danish students and IPB teachers, taking an external advisory role on the evolution of the Danish students' projects. Lillebaelt Academy teachers would also follow up the Portuguese students' progresses and would have the symmetrical role.

Table 1 illustrates the course structure and the chronogram with the expected interactions throughout the program. The 2-week visit in the international week

would be an opportunity for the Danish students also to perform laboratorial activities at the IPB's Mechanical Technology Labs and engage in cultural activities with their counterparts.

***Table 1**: The course structure where the arrows represent interactions between Portuguese teachers and Danish students and vice-versa*

<table>
<tr><td colspan="4">Lillebaelt Academy (EAL)</td></tr>
<tr><td>5 weeks</td><td>5 weeks</td><td>5 weeks</td><td>2 weeks</td></tr>
<tr><td>Innovation & technology development</td><td>Documentation project – design, calculation and blueprint development</td><td>Production – Development of the production phases and methodology</td><td rowspan="5">International visit - Laboratory work and cultural activities</td></tr>
<tr><td colspan="3">↕ ↕ ↕</td></tr>
<tr><td colspan="3">Instituto Politécnico de Bragança (IPB)</td></tr>
<tr><td>5 weeks</td><td>5 weeks</td><td>5 weeks</td></tr>
<tr><td>Innovation & technology development</td><td>Documentation project – design, calculation and blueprint development</td><td>Production – Development of the production phases and methodology</td></tr>
</table>

***Figure 2**: Danish teaching staff working with Portuguese groups at their visit during the Innovation and Technology Development module*

Mutual opportunities

The opportunities for the IPB's contribution are threefold: providing the venue and conditions for the international visit from the Lillebaelt Academy students with tailored classes, sharing teachers' knowhow and providing laboratory experience. The structure of the course at Lillebaelt Academy is maintained but a new course is created at IPB mirroring the structure, organization and evaluation scheme already in use at Lillebaelt Academy.

There are large benefits to be harvested from both Institutions from this course. In the case of EAL, it must be emphasized the further development of their international model and opening the channels between Danish Higher Education entities such as EAL and foreign industry. The opening possibilities for Portuguese Higher Education entities such as the IPB to be closer to the Danish industry would also pose as a major gain.

For the IPB case it enables a hands-on experience on a Project Based Learning methodology for a whole semester that may become, in the future, a standard at IPB. This course will enable the IPB's staff to be involved and acquire expertise in the execution of a PBL course.

Future steps

The course is not finished so it will be premature yet to state the conclusions from this experience. How was the students involvement?; have they achieved minimum skills required for approval?; what were the forces against changes?; what were the problems in regards to coordination between teachers and between two institutions, EAL and IPB?; what is the global outcome of this experience? are amongst several of the questions that still need to be answered for future adaptations and dissemination of PBL methodology at the IPB.

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