Chapter 17
Effectiveness of Problem Based Learning for Engineering Curriculum

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ABSTRACT

The main purpose of this case is to describe the process by which an initially limited-range practical experience, within the frame of a given course in an aerospace engineering degree, might be expanded to become the mother-course itself. Particularly, the practical experience is a Model Rocket Workshop (MRW), where students design, simulate, build, test and launch a small model rocket. The workshop is a Problem Based Learning (PBL) experience that covers a wide spectrum of educational aspects, ranging from theoretical disciplines, such as fluid dynamics and rocket dynamics, to topics more related to experimental work and hardware utilization like the certification of the rockets, as well as the rocket altitude measurements. Students get rapidly involved in the project, and acquire several practical and transversal abilities, while developing a solid knowledge of the physics underlying aerospace engineering. The case study shows some problems and improvements, academic results and lessons learned from the PBL approach. Finally, a series of new ideas related to MRW and to the course it belongs to are presented. The objective is to expand the MRW so that it embraces the totality of the activities that constitute this mother-course. As a consequence, the former would then become a new course entirely based on PBL. The strategy aims at enabling an optimum transition from conventional learning to PBL.

ORGANIZATION BACKGROUND

The Universitat Politècnica de Catalunya (UPC) is a public higher education institution and one of the leading universities in Spain. The fields of research and education of the university are architecture, sciences and engineering. The schools and research centers are known, nationally and internationally, for educating and training technological professionals and for the high-quality research done in these areas. The university seeks excellence in teaching technical courses that are responsive to the training needs and requirements of traditional, evolving and newly-developing production sectors, including aerospace engineering, photonics, supercomputing, bioengineering, water resources and management and energy. All of them meet the criteria and requirements of the European Higher Education and Research Areas. Also, the substantial ability for technology transfer insures that the research generated by the technological and scientific teams has a real-world impact not only within Spain but also world-wide.

The University was officially founded in March 1971 and at present it offers 61 graduate and undergraduate official degrees, enrolling a total of about 29,500 graduate and undergraduate students. For some of these programs the university has international agreements with other technical universities to endorse double-degree diplomas, totaling 82 double-degree programs. Thus, the university has an international profile and it has about 2,300 students in international exchange programs. It is the Spanish university with the highest number of master's degree students from abroad. These programs have a natural continuation in 47 doctoral programs, enrolling 2,900 students.

The research activity of the university is undertaken by 40 departments, and it is funded by about 6,600 research projects, with a global research income of 72 million euros. It is the Spanish university with the highest research income from the European Union VI Framework Program.

The overall scientific production during the last year was 1,600 papers, some of them in the most prestigious journals, like Science or Nature, to put some examples. It is the Spanish university with the highest citable output in the fields of Computer Science and Information Technologies; Mechanical and Aeronautical Engineering; Civil Engineering and Architecture; Electrical and Electronic Engineering and Automatic Control; and Electronic and Communications Technologies. The faculty and research staff amounts to 2,600 people, whereas the administrative staff amounts to about 1,500. The total budget of the UPC is 320 M€. Finally, the UPC is member of several international university networks (CLUSTER, CESAER and CINDA…).

The Escola Politècnica Superior de Castelldefels (EPSC) was founded in 1991 with the clear purpose of specializing in innovation in teaching methodologies. Since then, it has achieved a solid reputation among the Spanish universities in teaching excellence. It offers several bachelor degrees in engineering, including a bachelor degree in Aerospace Engineering. Special emphasis has been laid on using fully cooperative or Problem Based Learning (PBL) techniques. Student performance is evaluated using continuous assessment. Additionally, virtual campuses and interactive learning platforms have been developed from the very beginning and are intensively used in all courses (a couple of these tools are presented later on). Most of these techniques or tools have been subsequently used in other engineering schools or campuses of the different universities in Spain.

SETTING THE STAGE

Problem Based Learning (PBL)

Graduate coursework in aerospace engineering is intended in large part to prepare students for professional practice of engineering in companies and state or international agencies and, in some

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