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Teaching, Learning and Exploring the Use of Project-Based Learning

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Introduction

The introduction in Higher Education Institutions (HEI) of models of teaching/learning flexible and adaptable to the profile and student learning style contribute to equality in access to higher education among students with different time availability. At present, the adoption of new pedagogical models is a challenge for HEI to integrate heterogeneous students, with distinct needs, mainly motivated by their professional situation [1–4].

The need for the introduction of project-based learning (PBL) in engineering was mainly the result of the many demands and comments received from interested employers and HEI. Despite the many years of study, many graduates may still demonstrate a lack of requirements fundamental to the industry, in terms of knowledge, skills and attitude.

Education and training in Department of Electrical Engineering (DEE) are an ongoing effort to provide academic programs that are focused on the labour market and oriented, through learning, to produce well-trained human resources and professionals who will be the driving forces for a sustainable development.

Procedures

Many national HEI are adopting Information and Communication Technologies (ICTs) to support teaching methods, making them, at the same time, more flexible and adaptable to students' profile and expectations. However, PBL is still far from being a constant methodology in undergraduate courses offered by HEI. All these institutions have developed or supported PBL pilot projects or other education methodologies. Also, the DEE of ISEC, being aware of the advantages that such a methodology may bring to the teaching/learning process, and wanting to give a positive contribution to the school's mission, supported the project that is presented here.

PBL is an idea and not necessarily a technique. It is very important to train students to master the crucial aspects of effective communication, deep understanding, and analytical thinking and other knowledge and values they may require [5–8].

This paper presents the work done in Electric Power Systems Project (EPSP) of the Electrical Engineering course, in which the methodology was carried out. Below are the objectives of the curricular unit of EPSP (Lighting topic) that supported the PBL strategy implementation.

EPSP is a unit of the second semester of the third year of the Bachelor's degree in Electrical Engineering. This curriculum unit aims to provide students with knowledge to conceive, model, analyze and design external lighting systems.

The class had twenty-seven students, divided into nine groups of three. At the end of this curriculum unit, each student should have a solid and fully updated reference framework of lighting systems, in which the relationship between lighting technologies and the real world, competition and competitiveness, gain new dimensions and shape.

Curricular EPSP framework

The main student motivation factors are the acquisition of new skills and the improvement or the update of engineering skills, contributing to their progression and career management in firms/companies and institutions, all of which may be achieved by getting an academic degree. On the other hand, the modern, faster lifestyle and the constant demand for high productivity rates makes the attendance of lessons quite difficult and the possibility of getting good results in any evaluation even more difficult for those who juggle a professional activity and school.

Thus, it is fully justified the approach to new forms of learning that, in a more flexible way, allow students to complement their training, whether as part of the

curriculum areas included in the plan, or simply as extracurricular training. It was in this context that this pilot project was developed, introducing a PBL component in a curricular unit where a more flexible training component was considered necessary.

As PBL has been defined in the most diverse forms, it is necessary and relevant to define the concept and scope of its use in this project. PBL is defined in this project as a system of interactive learning supported by information and communication technologies, involving an integrated structure of pedagogical resources and technical support. The strategy of this project is to provide an interactive learning process that ensures a strong student/teacher interconnection and communication, which is the ultimate intention of a PBL project.

In the process of PBL it is intended that the student will never feel alone or without monitoring and/or guidance whenever he/she encounters difficulties. There must be an integrated structure of pedagogical resources – this means that all contents and pedagogical activities are specifically designed for self-study, providing mechanisms for progress evaluation, consolidation of knowledge and self-assessment. Pedagogical support at guidance and motivation and explanation levels is also made available. As technical support, students were provided with a software tool, Dialux 4.3 [9].

With this model students must be able to learn for themselves, should also have high self- discipline and great motivation capacity [2, 6].

It was found that all the necessary conditions existed to ensure the quality of the project, ensuring that students would not have difficulties of access to contents, tools and the activities available, thus making the new model a higher quality education system when compared to the traditional one.

In the short term, and based on this Project, there is the intention of implementing learning models which contribute to the mission of DEE and serve the objectives of:

- To reduce school failure rates;
- To provide alternative forms of class attendance where students may choose the one that better suits their profile as well as learning style;
- To allow worker-students the continuous development of their training, acquiring and improving skills, without compromising their professional situation;
- To stimulate a culture of self-study and accountability for the learning process;
- To develop further complementary training by using this approach.

Project-Based Learning strategy

One of the purposes of this project was to enable students to design an external lighting project to meet a requirement of the community. Groups of three students performed the task but each team member was given specific assignments towards a common goal. Different projects were assigned to all teams. The real problem that was proposed covers most of the contents of this course (interior and exterior lighting). The resources were divided into topics, so that each team member had part of the information necessary to complete the proposed task. Each team member was assigned a specific task within the group, using the necessary analysis and studies of lighting project design in order to achieve the main objective [10–11]. Throughout the period of four months, it was expected that students would learn to use new computer tools, in particular the Dialux 4.3 software, so that they could design and simulate appropriately, an outdoor lighting system for various urban spaces in the city of Coimbra. Students had to determine the current lighting levels and present results with a more appropriate and efficient lighting solution. They also had to present a simulation and prepare the presentation and final project documentation [12–13]. The team presentation was selected at random, within the team, to ensure a positive interdependence among the team members [10].

The Laboratory of Research and Technological Innovation of ISEC (LRTI/ISEC) provided the laboratory learning and allowed the development of experimental skills, facilitating the ability of students to work in teams, to communicate effectively, to learn from mistakes as well as to be responsible for their own results. Because of the costs involved, virtual instruments were used, through computer simulations, to experiment practical, real life situations. From the students' point of view, the laboratory became really attractive and useful to learn about lighting theory [14–16].

The philosophy of PBL is the training of students in "learning to learn" [6]. A decisive aspect of this learning technique is the power to directly and immediately apply the theme and the knowledge acquired. Furthermore, PBL also improved the way students learn to develop management and communication skills, leadership skills, teamwork, and other various generic skills necessary to engineers [7].

The project submitted aroused the curiosity of students to learn more and this resulted in the development of new ideas and the attempt to find solutions to the problem with the help of the software provided. There have been many debates and discussion sessions through which students, within and among the different groups, were able to exchange relevant information and ideas that were useful for the completion of their projects. Students also improved their capacity to study by conducting research in the library, making references, extracting information and, through simulations, have also been exposed to the future labour market and real life [17].

PBL methodology succeeded once the students became more proactive, creative, innovative and more responsible in their academic development. At the end of the project, the majority of students said they had gained a lot, both in terms of theory as well as in more practical aspects.

Case study

The Avenida Sá da Bandeira.

One of the projects, as a case study, was an urban area which is Avenida Sá da Bandeira, in Coimbra. This avenue was projected in 1889, and served initially as a

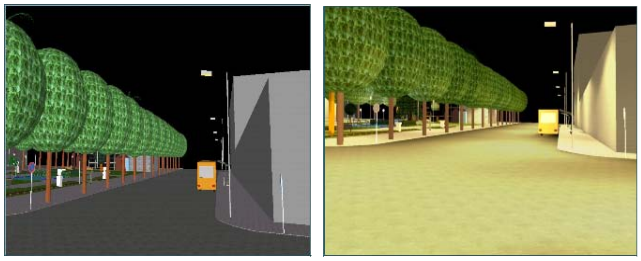
kind of public promenade, thereby connecting the lower area, D. Luís square (today called Praça da República) and the University of Coimbra. The central garden was designed in 1928. The Lighting project of Avenida Sá da Bandeira in Coimbra is part of a study of the redevelopment of important areas of the city. The project was to study the area in order to learn about the lighting system currently used as well as the historical and architectural places of interest that need to be enhanced with adequate lighting [18–23].

a) b)

Fig. 1. Photos of Avenida Sá da Bandeira and central garden

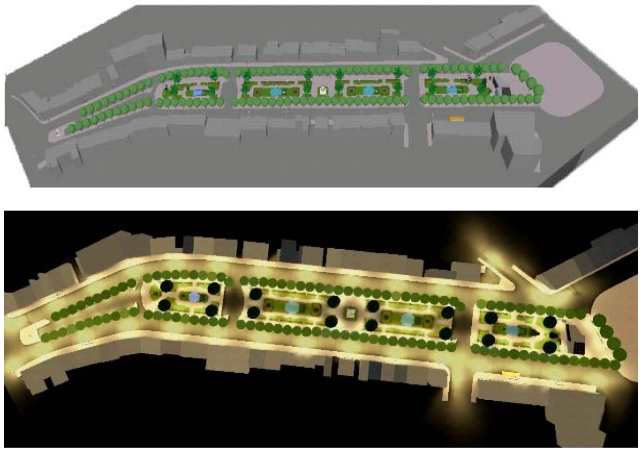
a) b)

Fig. 2. Simulation of Avenida Sá da Bandeira (top) – Dialux daytime/nighttime images



a) b)

Fig. 3. Simulation of Avenida Sá da Bandeira (bottom) – Dialux daytime/nighttime images



a)

b)

Fig. 4. Simulation of Avenida Sá da Bandeira (top view) – Dialux daytime/nighttime images

Project Evaluation

The project aimed at developing the individual responsibility of students in their learning process; assessing their performance throughout the process, forcing them to reflect and review the whole project, and, at the same time, making them aware of the development of their learning skills. The final report was based on their own observation process, rather than a mere description of a process. Students received significant feedback on their individual progress. In addition to this, a student of each team was selected at random by the teachers to present orally the team project – from process/methodology to the final product. The final grade was given to all members of the team based on this individual performance. The random selection was used to promote individual responsibility, as well as the involvement of all the team in sharing information throughout the process [10].

Discussions and conclusions

PBL is considered a good way to prepare students for engineering and technology programs. This study indicates the effectiveness of PBL in educating engineering students to make them more responsible in the contents area as well as in generic competences. By using PBL students get the opportunity to work or simulate real problems, making the learning experience much more meaningful. It is advisable that cooperative or collaborative learning is introduced to have students accustomed to real, effective group work.

As it was mentioned earlier, the PBL methodology adopted for this project was an approach to the development of skills. With a strong component of self-study, this approach allows the customization of the learning pace and time management. In this context, the student is at the centre of the process, having the main role, being in charge of his/her learning, but with the interim support of asynchronous sessions that put him/her closer to the system, and provide the guidance and motivation for the challenges ahead [13].

After finishing the course, most students found placing almost immediately in businesses.

The project was very positive, enhancing factors that motivate the continuity and the implementation methodology to other disciplines and/or courses. The method adopted – PBL – proved appropriate to students' profile and appropriate to the objectives

of the curricular unit. The existence of the PBL option, by itself, has shown an increment in the success rate in the curricular unit of EPSP.

Finally, it is considered that this PBL model can be extended to other curriculum units of this course, either complementary or as an alternative to the traditional education model. With this approach the students had the opportunity to get familiar with the search and browse learning through the Internet, magazines, books and materials. The assessment was based on the merits obtained with regard to the nature of the project, the solution for the problem, the individual and group participation, as well as aspects of creativity in their presentation. At the end of the semester the students got better grades when compared with the previous school year, when PBL had not yet been applied.

Considering that this was a pilot-project, the conclusions of this study were encouraging both on the part of teachers and students. The results show that students have benefited from the experience of actually working as members of a team in relation to learning using conventional classes.

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Education in academic institutions of higher education is not an easy task, with engineering students needing to be competent in the contents areas as well as in a generic way. This paper describes the implementation of a strategy of the PBL model applied to design a curriculum unit of Electric Power Systems Project (EPSP) of the Electrical Engineering course. This curriculum unit aims to provide students with knowledge to design, model, analyze, and project interior and exterior lighting systems. The results show that students have really benefited from the experience of actually working as members of a team rather than learning using conventional classes. Ill. 4, bibl. 23 (in English; abstracts in English and Lithuanian).

M. T. Valdez, C. F. Agreira, C. M. Ferreira, F. P. Maciel Barbosa. Projektais paremto mokymosi modelio taikymas mokant ir mokantis // Elektronika ir elektrotechnika. – Kaunas: Technologija, 2010. – Nr. 9(105). – P. 117–120.

Inžinerinės krypties studentai privalo būti kompetentingi ne tik savo srityje, bet ir apskritai. Aprašoma elektros inžinerijos kurso diegimo strategija taikant projektais paremtą mokymosi modelį ir elektros sistemų projekto planą. Šiuo mokymosi planu studentams siekiama suteikti žinių apie vidaus ir lauko apšvietimo projektavimą, modeliavimą, analizę ir kūrimą. Rezultatai rodo, kad studentai gavo daugiau patirties iš darbo su visa komanda, nei būtų gavę iš įprastinių paskaitų. Il. 4, bibl. 23 (anglų kalba; santraukos anglų ir lietuvių k.).

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