

Project-based Learning as an Effective Developer of Young Engineers' Curriculum

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CORPORATE DEMAND ON YOUNG GRADUATES SKILLS

As the demand from the industrial and corporate world for an improved engineering education system increases, Europe2020 strategy for Education in Europe pushes for an education system that better prepares students for the future employer's needs. The sustainable development of the economy can only be supported by a high quality education, integrated with the best contemporary practices and technologic support available [1]. In 2013, the European Skills, Competences, Qualifications and Occupations (ESCO) system was created, aiming to bridge the gap between the world of education and training and the labour market. ESCO identifies and categorizes skills, competences, qualifications and occupations relevant for the EU labour market and education and training. Interestingly, it

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emphasizes the importance of a better identification and management of availability of the required skills, competences and qualifications where the transversal skills (also known as soft skills) have an important role, once they can be applied to more than one sector [2].

With this, there has been an increased focus in the field of European Engineering Education (EEE), to adapt the traditional system of engineering lectures into new models. These models are thought not only to prepare engineering students for the technical challenges of their future, but also to provide the complementary skills required in today's job market. Project-based learning (PBL) is one of the models meeting the elevated requirements of working life. It is defined as "a model that organizes learning around projects" [3], and as a "comprehensive perspective focused on teaching by engaging students in investigation" [4]. PBL has been shown to increase learning effectiveness, student motivation and student engagement [5].

The Summary of the 2014 Survey findings of the Engineering and Technology Skills and Demand in Industry [6] stresses the lack of practical experience, leadership skills and technical expertise, as it is shown in Fig 1. The results show that Graduates are perceived to lack practical experience by 42% of the respondents, leadership skills (24%) and technical expertise (23%). When asked for suggestions to improve and promote engineering to young people, over half of the employers suggested working close with education providers has a solution.

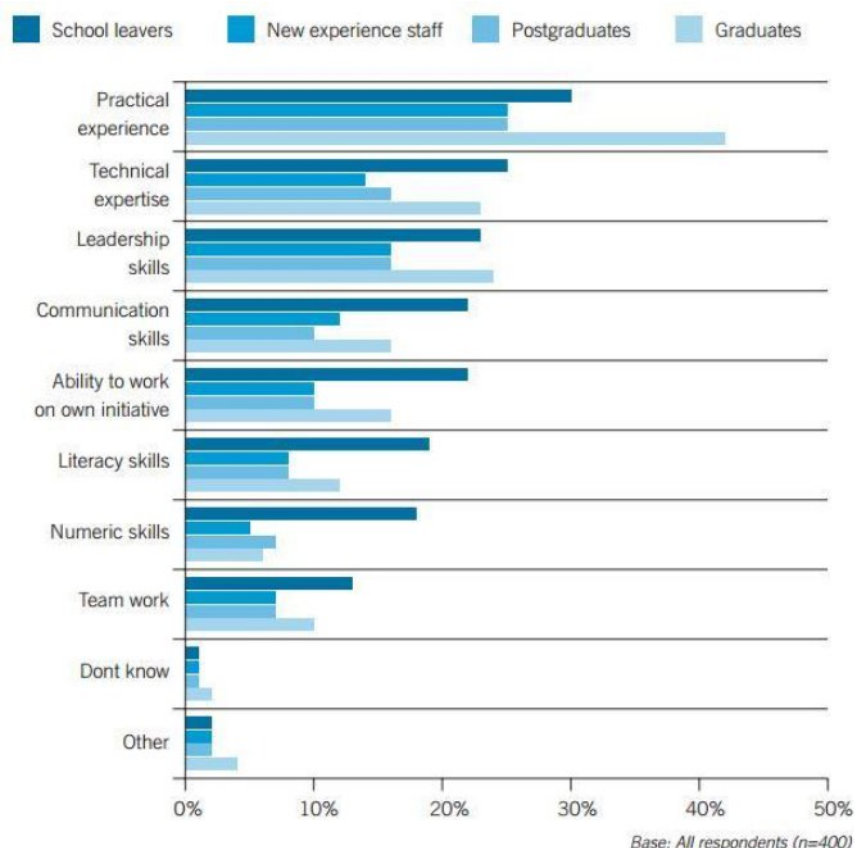


Fig. 1. Skill shortages of recruits (from Summary of the 2014 Survey findings of the Engineering and Technology Skills and Demand in Industry [6])

As a student's NGO, Board of European Students of Technology (BEST) is interested in developing the education system to best develop students and prepare them for the corporate world. To better understand the stakeholders' perspective on

the role of PBL as an effective learning method and curricular developer in EEE, BEST has organised surveys and Events on Education (EoE). Thus, in this paper BEST presents the analysis of the students' input regarding PBL as a key-method in engineering education to bridge the gap between university knowledge and the skills needed in their jobs. The input is also compared with opinions from both universities and companies, as relevant stakeholders of education.

1 METHODOLOGY

1.1 Events on Education

Events on Education (EoE) were created in order to raise awareness and involve students in the process of education improvement. There are two types of EoE: BEST Symposia on Education and BEST Academics and Companies Forum (BACo). A symposium only involves students and academia, whereas a BACo additionally involves companies. Both types of events have a similar goal: giving students the opportunity to express their opinions through discussions with the other stakeholders. In order to obtain results representative for EEE as a whole, 22 technology students from different countries, representing different backgrounds, participate in each event.

Three EoE had topics which were either directly or indirectly related to PBL. A symposium was organised in Trondheim in 2001 which investigated PBL in all its aspects [7]. During BACo Bucharest in 2008, accreditation and learning outcomes were discussed [8]. Finally, EoE Aveiro in 2013 was organised [9] where PBL was discussed with respect to three main topics: the accreditation of soft skills in the curriculum, the attractiveness of engineering education and university-industry relations at several points.

During the sessions at each EoE members of the Educational Committee of BEST act as facilitators. The role of a facilitator is to guide the session in an efficient way, encouraging everyone to participate without making their own opinion apparent. To this end, several facilitation methods are used. These include the following: brainstorming, SWOT analysis and world café, also known as learning café. Brainstorming is used in an initial phase to generate ideas. Afterwards, for a more serious analysis of the ideas and topics, SWOT analysis is used as well as contrasting advantages and disadvantages of the topic. Finally, the world café method is used to gather input in an informal way. The students are divided into groups, and each gets a different topic. After a round of discussion, the groups switch topic and are allowed to see the results of the previous group [10].

1.2 Market research

In 2014 BEST conducted a survey with 29 different universities across 19 European countries, asking university representatives their opinion on different topics regarding engineering education. The involved universities are highly diverse in background, geographical position, international ranking and number of students. The survey included 9 questions that tackled important topics such as the importance of extracurricular activities, skills students should develop, international mobility and the relationship between universities and companies [9].

2 STUDENTS' OPINIONS ON PBL AS A CURRICULUM DEVELOPER

The symposium organised in Trondheim in 2001 [7] offered students the opportunity to examine four aspects of PBL: implementation, infrastructure, evaluation and motivation. When discussing the implementation aspect, the students identified key elements of a PBL course. They emphasized the importance of a proper theoretical

preparation before and guidance during the project work, yet the precise methodology would differ for each field. The students stated that time-consuming projects are not necessarily the most efficient ones. Therefore the workload of parallel courses should be coordinated to take these projects into consideration. Secondly, the students talked about infrastructure. They concluded that the university should facilitate the teamwork of the students by providing meeting rooms and workspaces with easy access. Thirdly, an adequate grading system was discussed. Students have stated that tutors involved in the guidance should also be part of the evaluation since they were in close contact with the groups. Periodic feedback and individual evaluation were deemed necessary. Finally, the students concluded that in order for PBL to work, both students and professors should be motivated. Therefore, students should have a say in the content of the project.

Later, in 2008 students indicated that it is important for an engineer to develop soft skills and to be open-minded in order to fulfil the European market requirements [8]. In EoE Aveiro in 2013 [9] the students ranked several teaching methods based on their effectiveness at developing a list of soft skills. Project learning and learning-by-doing came out on top. Another key topic of the EoE were the university-company relations where PBL was discussed because of its potential to bring universities and companies together. A traditional approach was compared with PBL, with respect to 5 aspects: resources, valuable skills, student challenges, advantages and disadvantages. *Table 2* shows the results of this comparison. It is shown that PBL requires additional resources: a company related to the field of study and funding for the project. Moreover, the traditional approach was shown to be more able to focus on a particular subject, whilst PBL excels at developing soft skills. Nevertheless both methods present challenges to the student. On one hand traditional lectures require the students to take notes and some students find it hard to pay attention. A project on the other hand presents challenges related to the teamwork and collaboration with the company. Finally, the advantages and disadvantages of each method were discussed. A traditional approach is easier to implement and allows for self-study, but it isolates the student whilst studying and doesn't force the student to be innovative. PBL is potentially very motivating, provides a real-life experience and is valuable to have on the CV, but the quality depends on the involved company and project.

Moti et al. (2003) present the perception and attitudes of freshman students which have taken part in a PBL course in engineering. They have shared their view on the aim of the course, characteristics, advantages, the instructor's role, PBL as a learning environment and the implication of learning in teams [10]. Mäntylä et al. (2012) present a similar analysis of a PBL course organised in collaboration with a company, showing that the students benefited from the course once they got to compare theory and practice and got in contact with possible employers [11].

Table 2. EoE Aveiro Students' comparison between traditional approach and PBL

	Traditional	PBL
Resources	Professor Clasroom	Professor Clasroom Company related to the field of study Funds for the project
Valuable skills	Responsiveness Focus	Teamwork Creativity Communication Time management Responsibility
Student challenges	Attention deficit Taking notes Sleeplessness	Getting along with the group Lack of some skills Company-related problems
Advantages	“Standard” Self-study possible	Real-life experience Learning by doing More valuable in CV Motivating
Disadvantages	Isolation while studying Unlikely to be “out of the box”	Dead-ends More time-consuming Company-dependent

3 ACADEMIA PERSPECTIVE ON SKILLS DEVELOPMENT AND PBL

One of the questions BEST asked universities in their survey was which they deemed to be the most important skills that a student should develop during their university life. They replied by indicating that these skills were teamwork (66%), communication (45%), project management (45%) and presentation skills (41%) [9]. It is of particular interest how the students' opinion expressed in *Table 2* is connected to what universities representatives replied when asked about skills. Two of what universities deemed to be the most valuable skills for a student to develop are covered in PBL while none of them are present in the traditional teaching method.

Moti et al. (2012) has also examined the teacher perspective regarding PBL. They point out three possible advantages for the teacher. Firstly, the work of the teacher is more varied as the projects differ each year, and offer the teacher a change of content. Secondly, the teacher will have to keep on learning as the students explore new projects. Thirdly, students tend to be more involved when a PBL approach is used. This makes it easier for the teacher to manage the classroom; there are likely to be less disciplinary problems. On the other hand, PBL presents several challenges to the teacher. PBL requires a lot of preparation, planning and effort. Teachers usually lack the experience when it comes to creating and teaching a PBL course and might, therefore, prefer a traditional approach [10].

4 SUMMARY

Companies are looking for graduates who possess the ability to work effectively in a team, adapt to the work culture and successfully transmit ideas [2]. However, the traditional university curriculum is not succeeding in the development of such competences [12].

BEST has organised surveys and EoEs to better understand the students and universities perspective on the role of PBL as an effective learning method in developing those skills. It was shown that university representatives recognised PBL-developed skills such as teamwork, communication and project management to be important in the students' curriculum [11].

Students have correspondently identified PBL as a more effective teaching method at developing those soft skills [7-9]. It has been shown that PBL improves learning effectiveness, student motivation and engagement [3-5]. Thus Its acknowledgement as an effective method might bring a brighter future to the curricular development in the mind-set of the modern job market.

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