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Preparing graduates for professional practice: findings from a case study of Project-based Learning (PBL)

Preparando a titulados para la práctica profesional: hallazgos de un caso de estudio basado en el uso del aprendizaje basado en proyectos (PBL)

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Abstract

This paper reports on a case study based on the use of Project-based Learning (PBL) in higher education to improve student learning and prepare graduates for professional practice. The theoretical background is based on the principles of active learning and the demands of the Bologna process for European Higher Education Institutions. These ideas are also aligned with the educational philosophy advocated by John Dewey, supporting the main goals of project-based learning approaches: linking theory to practice by solving real life problems related to learners' future professional contexts. The paper will present findings based on students' and teachers' perceptions in regard to the effectiveness of PBL in preparing graduates for professional practice. Data collection was based on a qualitative approach, using questionnaires and focus groups for students, and was semi-structured for teachers. Findings are presented according to the three main categories emerging from the data: linking theory to practice, developing skills for professional practice, and difficulties and challenges of PBL. Based on students' and teachers' perceptions, it can be concluded that PBL fosters deep-level learning and important skills for professional practice, as the development of the project provides a real life context for linking theory to practice. Students are able to relate their work to broader professional situations outside the academic world. The difficulties and challenges of PBL are mainly related to the

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heavy workload which it entails and the assessment method. These issues require further reflection and improvement. Implications for teaching and learning in higher education are discussed.

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Keywords: higher education; project-based learning; professional practice; students' and teachers' perceptions;

Resumen

Este artículo está basado en un estudio de caso sobre el uso del aprendizaje basada en proyectos (Project-based Learning - PBL) en la educación superior para mejorar el aprendizaje del estudiante y preparar a los graduados para la práctica profesional. El marco teórico se basa en los principios del aprendizaje activo y las exigencias del proceso de Bolonia para las instituciones europeas de educación superior. Estas ideas también están alineadas con la filosofía educativa defendida por John Dewey, el apoyo a los principales objetivos de los enfoques de aprendizaje basadas en proyectos: vincular la teoría con la práctica, mediante la resolución de problemas de la vida real relacionados con los alumnos en el futuro contexto profesional. El artículo presenta los resultados basados en las percepciones de los estudiantes y de los profesores en cuanto a la eficacia de PBL para preparar a los graduados para la práctica profesional. La recogida de datos se basa en un enfoque cualitativo, utilizando cuestionarios y grupos de discusión con los estudiantes y semi-estructurada con los profesores. Los resultados se presentan de acuerdo con las tres categorías principales que emergen de los datos: vincular la teoría a la práctica, el desarrollo de habilidades para el ejercicio profesional y las dificultades y retos de la PBL. Basado en las percepciones de los estudiantes y de los profesores, es posible concluir que el ABP fomenta el aprendizaje a nivel profundo y habilidades importantes para la práctica profesional, ya que el desarrollo del proyecto proporciona un contexto de vida real para vincular la teoría con la práctica. Los estudiantes son capaces de relacionar su trabajo a situaciones más amplias y profesionales fuera del mundo académico. Las dificultades y los desafíos de la PBL se relacionan principalmente con la pesada carga de trabajo y el método de evaluación de los estudiantes. Estos temas requieren una mayor reflexión y mejora. Se discuten las implicaciones para la enseñanza y el aprendizaje en la educación superior.

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1. Introduction

The educational reform introduced by the Bologna Process in European Higher Education Institutions has resulted in deep changes in the way teaching and learning are perceived and implemented by academics (Froment, Kohler, Purser & Wilson, 2006; Eurodyce, 2010). The call for revised programs and course structures, followed by new teaching methods that focus not only on the achievement of technical competencies but also the development of skills in human relations, are some of the goals to be accomplished. In the context of Engineering Education, Mills & Treagust (2003) point out a set of critical issues that need to be addressed for significant changes in current philosophy and delivery of engineering education. These authors argue that:

«Engineering curricula are too focused on engineering science and technical courses without providing sufficient integration of these topics or relating them to industrial practice. Programs are content driven; (...) Graduates still lack communication skills and teamwork experience and programs need to incorporate more opportunities for students to develop these; (...) Existing faculty lack practical experience, hence are not able to adequately relate theory to practice or provide design experiences. (...) The existing teaching and learning strategies or culture in engineering programs is outdated and needs to become more student-centred» (pp.3-4).

The need for more student-centred engineering programs, which provide design experiences to students, foster the development of soft skills and the link between theory and industrial practice are some of the recommendations. According to this, new educational methods and strategies are needed in order engage students in the learning process and guarantee higher quality at undergraduate programs. Project and Problem based Learning (PBL) are some examples of educational approaches that take in account student-centred learning. With project-based learning

students work together in teams to solve large-scale open-ended projects. The key features of the PBL aim at fostering student-centeredness, teamwork, interdisciplinarity, development of critical thinking and competencies related to interpersonal communication and project management (Powell & Weenk, 2003; Helle, Tynjälä & Olkinuora, 2006). By learning through projects and teamwork, students move from merely listening and reading about abstract concepts to working with their teammates in applying those concepts in order to solve real-world problems (Michaelsen, Knight & Fink, 2004).

These principles of PBL are aligned with the educational philosophy of John Dewey (1916), who advocates the idea of learning by doing. Dewey argues that students must be at the centre of the learning process and that they should develop skills that prepare them for the future. Dewey makes a strong case for the importance of education not only as a place to gain content knowledge, but also as a place to learn how to live. According to Dewey, the teacher's role is not to deliver information to passive students, but to act as a facilitator of the learning process, guiding the student as he/she progressively develops as an independent learner.

Considering the key ideas briefly presented to support the theoretical background of this paper, a case study based on the use of Project-based Learning within the context of a first year engineering degree at the University of Minho, Portugal, will be analysed. The study will discuss the effectiveness of PBL to improve student learning and prepare graduates for professional practice.

2. Context of the study

The case study reported in this paper was carried out at a Portuguese university, located in northern Portugal. Project-based learning (PBL) has been implemented in the first semester of the Industrial Management and Engineering (IME) program since 2003-2004, with the overall goal of fostering interdisciplinary approaches in engineering curricula and increasing student motivation for learning (Lima, Carvalho, Flores & van Hattum-Janssen, 2007). Interdisciplinarity is a key feature of PBL, as students need to understand and apply different subject areas to solve large scale open-ended projects, by linking theory to practice. Students are also encouraged to handle teamwork and project management, skills which enhance some of the required skills that students are expected to achieve in this course (Mesquita, Lima & Flores, 2013). Besides these motivations, PBL is an important strategy to help prevent dropout problems and improve approval rates of first year engineering students (Tavares, Santiago, Taveira, Lencastre & Gonçalves, 2000; Powell & Weenk, 2003; Lima, Carvalho, Flores & van Hattum-Janssen, 2007).

The implementation of PBL in the first year of the IME program is supported by four of the five courses of the study plan of the first semester (Lima, Carvalho, Sousa, Alves, Moreira, Mesquita & Fernandes, 2012). The project is coordinated by a team made up of the course coordinator, lecturers, tutors and researchers. The student teams are composed of six to eight students. They are guided by a tutor that supports them and monitors the development of the project. The tutor's role is to facilitate and monitor student's learning process (Veiga Simão, Flores, Fernandes & Figueira, 2008). The project includes a set of milestones throughout the semester which aim to monitor and assess the project's progress and provide students with feedback to improve learning. These are also important moments for the coordination team to track underperforming teams and support them in solving their problems.

Student assessment in PBL is based on two main components: a) specific assessment tasks, work assignments, written tests, which the lecturer of each course is exclusively responsible for; b) and specific elements related to the project, such as oral presentations, project reports, prototypes, peer assessment, written test on the project, which all the coordination team members are responsible for preparing and assessing. Each of these two main components have a weight of 60% and 40%, respectively, on students' individual classification. This situation happens because the project is not a specific course of the semester, but the lecturers involved in the four courses of the semester recognize the importance of the project for student learning and agree to include the assessment of the project within their courses. It is important to notice that since 2012-2013, the IME curriculum was redesigned and a project course was included in the first semester of the first year. Until then, and this is the situation concerning the data reported in this study (2006-2008), the project was grounded on the four project-supporting courses existing in the first year of IME curriculum.

3. Methodology

This paper seeks to address the following research questions:

1. How does PBL prepare students for professional practice?
2. What are the advantages and difficulties of PBL for students?
3. What are the implications of PBL for teaching and learning in higher education?

Data are drawn from a broader research project held within a PhD study carried out at the University of Minho, Portugal (Fernandes, 2011). Participants in this study included students and teachers involved in PBL editions carried out from the academic year 2005/2006 to 2007/2008. The research design was based on a qualitative approach, where a diversity of methods were used for data collection (Denzin & Lincoln, 1994). For the purpose of this paper, the selected data will focus on the research methods which explored issues related to the main theme of this paper - students' preparedness for professional practice. These methods include individual questionnaires and focus groups to students and semi-structured interviews to teachers. Besides this, a document analysis was also carried out, which in this case, is focused mainly on the analysis of student's answers to a written test based on the project.

Table 1: Phases and Methods of Data Collection

Phases	Academic Year	Participants Involved	Research Method
1st Phase	2005/2006	40 Students (1st year)	Individual Questionnaire
	2006/2007	40 Students (1st year)	
2nd Phase	2007/2008	22 Students (2nd year)	Focus Groups (3)
		5 Teachers	Semi-structured interviews (5)

For data analysis, a preliminary content analysis was carried out to identify data under the theme related to "student's preparedness for professional practice". Other categories were also identified, but they are beyond the scope of this paper (please see Fernandes, Mesquita, Flores and Lima, 2014; Fernandes, Flores and Lima 2009, 2012a, 2012b; Fernandes and Flores 2013). Recurring topics under this theme, as well as contrasting patterns amongst participants' perceptions, were carefully analyzed in order to identify the important subcategories to be defined (Miles & Huberman, 1994).

4. Findings

Under the general category of 'student's preparedness for professional practice', three subcategories were identified: linking theory to practice, developing skills for professional practice and difficulties and challenges of PBL. These topics will be explored in the next sections.

4.1. Linking theory to practice

According to students, PBL focuses on deep-level learning and critical thinking, as the development of the project provides a real life context for linking theory to practice. In this way, students relate their work to broader and professional situations outside the academic world. Students' were greatly satisfied with the level of interdisciplinarity fostered by the projects' goal and assignments. This positive outcome was referred by students on the individual questionnaires and during the focus groups discussions, as seen in the following quotes:

"Sometimes we were in classes thinking – how will this subject be useful for me in future life – and we could actually understand the meaning and application of things."

"Because there were different courses of the semester involved in the project, it made us develop the technical skills needed for the project. At the same time, we were also more interested in the different subject areas since we could see the direct application of the concepts that we were learning in the project."

“This year (Non PBL) it is more difficult to recognize the usefulness of what is learned. Courses are more theoretical. It is more difficult to make the connection between reality and what is being taught in classes.”

“In PBL, I learned a great deal of concepts. I didn’t just hear about them, I actually saw their application in real cases. We learn much more with PBL and this is also visible in the grades we achieve.”

However, it was also possible to find out that not all students were enthusiastic about PBL. The reasons identified for this negative attitude towards PBL reveal some interesting findings in regard to students' role in the learning process and with student's views of assessment and its impact (Fernandes, Flores & Lima, 2012a). Data from the questionnaire applied to students, six months after the project was concluded, revealed that many students had preference for traditional teaching and assessment methods, in which they could play a more passive role in the learning process. Some students recognized that they felt more comfortable when assessment was only dependent on their performance (not on a group) and when study efforts were related only to course contents, lectures in which students did not have to worry about applying or linking the concepts to real life situations or with other courses during the same semester.

“The non PBL approach is better for us because the contents taught are directly related to what will be assessed in examinations and not focused on a project’s theme.”

“We learn more without PBL. PBL takes a lot of our time and we don’t even apply all we learn in the written tests.”

“Without PBL, we can study in a more individual way and we can study the contents for the test without being worried about the application of those contents.”

These perceptions from students reveal different approaches to learning which may be linked to what Marton (1976) identified as deep and surface approaches to learning. They are consistent with findings from similar approaches, such as Entwistle and Tait (1990), who found out that students who reported themselves as adopting surface approaches to learning preferred teaching and assessment procedures which supported that approach, whereas students reporting deep approaches preferred courses which were intellectually challenging and in which assessment procedures allowed them to demonstrate their understanding.

4.2. Developing skills for professional practice

Students highlighted that one of the most positive aspects of PBL was teamwork. It provides the opportunity for students to develop transversal skills such as problem solving, time management, oral and written communication skills, amongst others. Students identified the benefits of working with people with different skills, ideas and perspectives, which allowed them to feel as if they were working in a real engineering environment. These findings are also consistent with the professional skills required for today's engineers, as seen also, for example, by the criteria adopted by ABET (Accreditation Board for Engineering and Technology) for the accreditation of all American engineering degree programs. The development of these important skills can be seen in the following examples referred by students:

"We also learned how to work as a team, how to solve problems within the group members so that these would not interfere with the progress of the project. We gained experience in doing oral presentations and how to control our nervousness. We learned how to make an effective project report. In sum, we learned about things that we had never even thought about but they are going to be very important for our future."

"I think participating in PBL was a positive experience because it allowed us to develop several competencies. Teamwork was the most important amongst all, as it will be very useful in our future professional practice."

Teachers also consider PBL as a good example of what awaits students in their future professional practice. The profile required for today's Engineers is increasingly more demanding and diverse, as transversal skills such as

teamwork, critical thinking, problem solving, creativity and ability to take risks are at the top of the list of most of the job requirements and also on the evaluation criteria for recruiting professionals. This was, indeed, one of the most obvious results identified by teachers interviewed, in regard to the impact of PBL on student's learning process. In teachers' opinion, the results are very positive at this level, as confirmed by the following statements:

"I think today things are increasingly influenced by the needs of the labor market, there is no doubt. And this way of learning (PBL) requires much more from an Engineer. It requires creativity! Today nothing is predictable and there are no recipes to solve problems, so either someone is sufficiently creative to find new solutions and be autonomous in their decisions... or they will not fit in the labor market. I remember when I did my PhD and I interviewed several professionals from industry and their main complaint about graduates was that they were excellent at executing things but very poor in findings solutions to new problems. They performed great academically but in the industry they were not capable of relating problem A, B or C to this, this and that. They were not able to take risks!"

"Students gain skills in areas that are not even listed in the courses. You look at their reports and in terms of quality, there is no comparison! And some students acquired skills in transversal areas which, in other circumstances, would never be developed. I know these things are difficult to measure in terms of outcomes, but in the long term, I think they will have a huge effect on their future career."

"I guess its (PBL) a good way of teaching. Some students just don't realize it at the moment. First, because they learn things like responsibility, that deadlines are to be fulfilled, that if they don't do something, no one else will do things for them. Just basic things. But these things prepare them more for their future life."

4.3. Difficulties and challenges of PBL

Besides the positive aspects mentioned above, students identified a set of difficulties related to this "new" way of learning. Students identify the heavy workload which the project entails as one of the main constraints of this approach to learning. In addition to this, students considered that the assessment method of PBL should be revised in order to increase student satisfaction in regard to the final grades achieved on the project (Fernandes, Flores & Lima, 2012a; 2012b). Students argued that the effort put in the project was not always equally shared by all team members and that this fact needed to be improved in the assessment method adopted in PBL. The following quotes confirm this:

"I consider that PBL occupies a great amount of students' time during the semester. However, it also helps us to learn how to work in groups and to learn by ourselves".

"PBL steals much of your personal life. We had to stay at the university to work all afternoons! And when we weren't working on the project, we had to study for the tests. And the subject content that we applied on the project wasn't even enough to study for tests. It was only one small part of the course program."

"I prefer traditional teaching instead of PBL because it is easier for me to achieve higher grades, besides the fact that I think assessment is fairer."

"With PBL, the grades achieved at the end of the semester did not reflect all of students' effort, hard work and commitment to the project. Besides this, we still had to study for the other courses, which is what happens this year."

The value placed on student grading is a recurring concern. When questioned about preferences in terms of PBL and non PBL assessment methods, almost all students' answers focused on the grades that they achieve. When justifying their choices, students stated reasons mostly related to the fairness of each method, dependent or not on a group component, and the effort required to achieve the intended learning outcomes.

Whether or not concerned with effective learning, some students proved to be solely interested on the easiest way to achieve high grades, and in this way, traditional lectures and assessment procedures were perceived to be more

appropriate. As one student states, “all study efforts are now [non PBL approach] concentrated on the contents that will be tested on examination and all my effort is focused on improving grades”.

"This semester [non PBL] I feel more engaged in the courses because all my study efforts are focused on studying the course contents. Thus, all my efforts in studying the courses' content will have a positive impact on my grades. Knowing this gives me more motivation as I know that all my study efforts are to improve grades."

"I think now (non PBL) the outcomes are better as we have more time to study and this has a positive impact on students' grades. Furthermore, PBL was disadvantageous because we worked a lot and, at the end, the final grades did not reveal that effort."

These findings lend support to previous empirical work. For instance, PBL experiences held in British universities (Saven-Baden, 2004) and other studies based on alternative ways of assessing student learning (Sambell *et al.*, 1997) also confirm students' disappointment with grades achieved, as they felt disempowered by the assessment system which did not value or reward effective learning. In some cases, students obtained higher grades on modules that were marked by an end-of-term exam rather than in courses with continuous assessment. There seemed to be a mismatch between the type of learning that took place and the respective assessment procedures which certificated learning (Saven-Baden, 2004). Future work should focus on ways of improving the assessment system to enhance student satisfaction.

4. Conclusions

Drawing on the findings from this study, it is possible to recognize the importance of PBL to improve student learning and prepare graduates for professional practice. Several evidences from students and teachers support this idea. Both students and teachers identify a set of benefits of PBL, such as teamwork skills, increased student motivation, articulation between theory and practice, problem solving, amongst others. The difficulties and disadvantages of PBL are identified by students as the advantages of traditional teaching and learning, such as the fact that the students' final grade does not depend on a group and the workload is also much less, leaving students with more free time.

The implications of PBL for teaching and learning in higher education are quite significant, not only in terms of changes in students' and teachers' role, but also in curriculum development. Learning outcomes, teaching strategies and assessment methods need to be clearly aligned with the educational philosophy adopted. Thus, it is important to ensure diversity in teaching and learning methodologies and provide students with rich and challenging projects, that will engage them in learning and in achieving the essential skills required for their future professional practice. In this concern, the UNESCO report is very clear in highlighting the importance of this connection: «University courses can be made more interesting through the transformation of curricula and pedagogy using such information and experience in more activity-, project- and problem-based learning (...) and less formulaic approaches that turn students off. In short, relevance works!» (UNESCO 2010, 32).

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