Project-based learning. Experiences from the initial stage of implementation in a higher education institution

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Abstract: Project or problem-based learning (PBL) has been recognised as a teaching method. Due to its major aspect of the highly practical implementation of knowledge in order to achieve a final product at the end of the course, it is very often applied in non-academic courses. However, the issue of PBL's implementation at higher education institutions is of a more complicated nature. Under those circumstances, the challenges are of a different nature. In this paper, experiences from the first stage of implementation of PBL at a *traditional* teaching university are presented and discussed. The implications for further steps are drawn as well.

Keywords: project-based learning; problem-based learning; PBL; new teaching method; knowledge application; university; experience; pilot implementation; innovation; learning.

Biographical notes: Seweryn Spalek is an Associate Professor at the Faculty of Organisation and Management at the Silesian University of Technology where he earned his PhD in Economics, Management. Since 1994, he has managed several projects in industrial companies and healthcare organisations, in multicultural and multinational environments. He was the author and co-author of several publications in project management. He participated as a speaker in several conferences related to project management and company management. He conducted research related to key success factors in project management and project management maturity. He is a member of AOM (Academy of Management), PMI (Project Management Institute), PMO SIG, PMI WPC, RISK SIG, IPMA (International Project Management Association).

1 Introduction

PBL, the short form of project-based learning, is also considered by some to be problem-based learning (Laxman, 2012; Ylitalo et al., 2012). It has been recognised as a kind of standard for effective knowledge delivery and was described by the Buck Institute for Education (2003) as follows: "PBL is a systematic teaching method that

engages students in learning essential knowledge and life-enhancing skills through an extended, student-influenced inquiry process structured around complex, authentic questions and carefully designed products and tasks" and assumed also by Prince and Felder (2006) as one of the teaching methods. The idea itself is, in its basic form, clear and a high-level definition has been mutually agreed upon (Kubiatko and Vaculova, 2011). However, there are different variations of its implementation (Frank et al., 2003; Friesel, 2004; Heitmann, 2005; Prince and Felder, 2006). The implementation of this method varies depending on the type of courses. Koutsabasis and Vosinakis (2012) describe courses including studio ones for practitioners, while Martinez et al. (2011) and Lamar et al. (2012) show how it could work in different areas of expertise. PBL could also be a part of traditional courses, e.g., IT-related curriculum (Hauser et al., 2007; Chu and Hwang, 2010; Hou, 2010). Furthermore, Codur et al. (2012) explain how it could be applied to regular courses for engineers. An interesting piece of work is presented by Scarbrough et al. (2004) describing three dimensions of PBL and the limitations of the application of those ideas. Furthermore, it was noticed by Andersen (2001) that the introduction of Problem and PBL to some universities brought positive outcomes.

It is noticeable that the biggest challenges could be recognised while implementing PBL at higher education institutions, e.g., at universities. Based on studies conducted on the implementation of PBL (Arthur et al., 2001), some authors highlight a few major challenges associated with: socio-cultural issues (Stauffacher et al., 2006), the behaviour of students (Hou, 2010), and motivation of the teachers (Lam et al., 2010). It was also observed by Rogers et al. (2011) that the implementation of PBL at universities creates new challenges and therefore, a new approach is needed for higher education in their opinion.

It is remarkable that such a limited number of studies have been conducted into the implementation of PBL at universities that only operate by using the traditional approach.

Therefore, by sharing experiences on the implementation of PBL at the Silesian University of Technology (SUT), we would like to fill in the gap of knowledge on PBL's implementation related issues in higher education, especially while introducing that approach to those universities with extensive experience in the *traditional* way of teaching.

2   The PBL method vs. the traditional approach

In the traditional approach, students attend different lectures and workshops during the course. In most cases, they need to separately pass tests in each subject at the end of the semester.

Furthermore, the traditional approach facilitates interaction between subject and student only which gives students the possibility to gain theoretical knowledge the most. In PBL, that crucial interaction exists as well, as knowledge is indisputably seen as the most valuable asset nowadays (Gasik, 2011; Liebowitz, Ayyavoo and Nguyen, 2007; Paliszkiewicz, 2011). However, all subjects are related to the one agreed topic of the entire project and the pieces of theoretical knowledge should be organised in a way that enables their application in the project. Moreover, in PBL, additional interaction takes place as well. The interaction between team-student allows individuals to gain knowledge of the team-building process and the assignment of different roles in order to achieve a common goal. Through practising, students learn how to assess their individual skills and

how to share responsibilities. The interaction between project-student delivers adequate project management knowledge. That goes through the full project life cycle from its initialisation, planning, execution and closing phase. Moreover, the students are taught methods, tools and techniques which are applied to manage projects effectively (Spalek, 2012; Trocki et al., 2011). It is noticeable that they gain theoretical knowledge of project management at first and then they need to apply it in practice by managing their project. The interaction between team-subject enables group-thinking processes in order to find out which specific theoretical knowledge delivered through the different subjects is relevant to their project. They need to find out and decide how to apply it in practice in their team. Project-subject interaction shows students how important it is to plan the project activities in-line with the knowledge delivered from the subjects. They learn how to create the project schedule in accordance with meeting the subjects' deliverables. They can even decide what kind of knowledge they are missing to proceed with the project and acquire it during the course. Through the interaction project-team, students learn that human resources are a vital issue of each project. They need to share, divide and/or assign resources. They find out how to allocate resources effectively in order to fulfil the project's needs. It is remarkable that all the above-stated interactions are explained to students at first on a theoretical basis and then, what is even more important, they have an opportunity to check how it works in practice while managing their project.

In the PBL approach, all student activities should be related to the one major topic of the project executed by the groups of students during the semester. According to Friesel (2005), the following presumptions should be made while trying to implement PBL:

- The students should be divided into teams consisting of around five persons.

- There should be supervisors assigned from the teachers to lead/coach the teams.

- There should be co-supervisors appointed to the merit issues related to the project topics.

- Each team should perform one project.

- The team should be encouraged to self-organise, including the assignment of roles and responsibilities.

- Each team should work out the conflicts' resolution plan.

- The project plan should be created at the beginning of the semester by the team.

- The work of students is assessed based on individual performance indicators. However, besides the traditional assessment of knowledge by subjects, the team and project work should be assessed as well.

- At the end of the semester, the team presents the outcomes of their project in front of the commission.

By implementing the above, students should be able to achieve new skills during the learning process, such as:

- teamwork

- practical application of gained knowledge

- project management skills

- conflict resolution.

By acquiring the above-stated skills, students would be more welcomed by industry upon completion of the courses.

It is also advisable to introduce the e-platform for PBL courses, something that was pointed out by Boss and Krauss (2007) to exchange knowledge by students and monitor the project's progress by supervisors.

In summary, the PBL concept attaches a high importance to the application of knowledge by students during each semester, a reality which meets with the expectations of industrial companies in delivering workers to the market who are already familiar with project team work. The approach of working as a team to complete projects seems to be crucial nowadays where more and more companies are running an increasing number of projects year by year. It means that they need graduates to be ready to work in a project-based environment immediately after leaving university.

3   The framework of implementation of PBL at the SUT

Based on some evidence of success stories of PBL's implementation and potential market need, a decision was made in 2011 by the Rector of the SUT to investigate the possibility of implementing PBL at SUT (Karbownik, 2011). In order to fulfil that need, the *feasibility project* was divided into two stages (Figure 1):

Stage 1   Acquisition of theoretical knowledge and practical experiences from other universities on PBL.

Stage 2   Pilot implementation in chosen courses and faculties on PBL at SUT.

Figure 1   The stages of the PBL feasibility project at the SUT
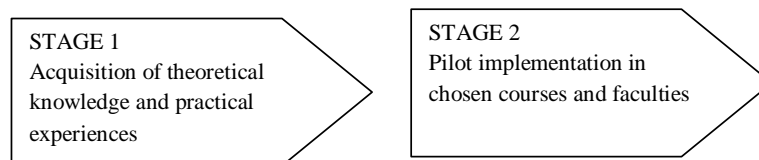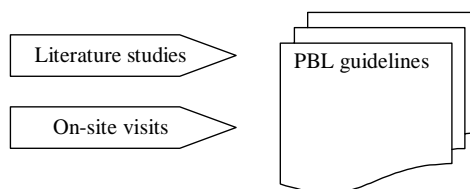

Figure 2   The first stage action flow

In the first stage (see Figure 2), appropriate literature studies and visits to universities abroad were undertaken to find out how these methods are applied in practice. The major result of the above-stated approach was that the implementation of PBL could vary a lot.

However, there are some common guidelines (as described in Section 2) one should start with in order to implement PBL. Those guidelines were used as the basis for the pilot implementation whose outcomes will be presented later.

In the second stage (see Figure 3), the following actions were undertaken:

1 After extensive deliberation, the decision was made to start the pilot implementation at two faculties: The *Faculty of Organisation and Management* (FO&M) and the *Faculty of Automatic Control, Electronics and Computer Science* (FACE&CS).

2 The appropriate courses at each of the faculties were chosen for pilot implementation. To increase the probability of success, the more mature students' group in their 4th year of education was selected.

3 The pilot implementations were limited to one group of students each. Then, the groups of students were divided into teams.

4 Each team had a different project topic assigned.

5 The supervisors and co-supervisors were appointed from the available academic teachers.

6 The course schedules were adapted to PBL needs accordingly.

7 At the end of the semester, each team had to present their project outcomes and pass theoretical tests as well.

Figure 3 The second stage action flow
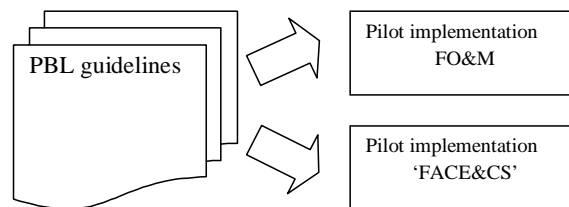
4 The outcomes from the pilot implementations

Although the implementation of PBL was done at the same university, there were some similar and some different issues at each faculty. The same issues were related to:
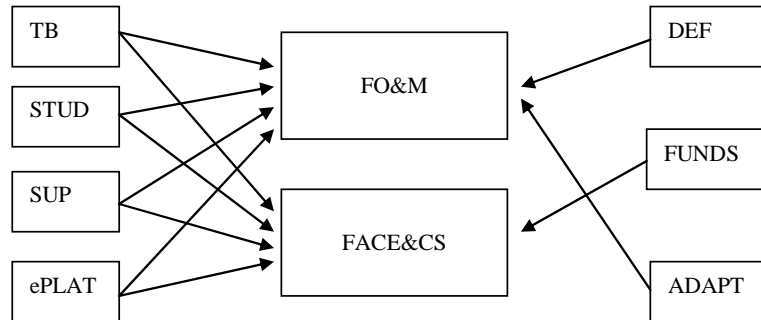
- team building – TB
- students' teamwork and motivation – STUD
- supervisors' assignment and motivation – SUP
- e-platform – ePLAT.

While the different issues were related to:

- definition of the project topics for the courses – DEF

- additional funds for courses – FUNDS

- adapting the semester schedules – ADAPT

The faculty dependencies of the above-stated issues are shown in Figure 4.

Figure 4   Dependencies between faculties and issues

4.1   Team-building issues

The issues related to team building were mostly connected with team formation. The major concerns were how to get the students to form effective teams. The first approach that the students assigned to themselves was not too efficient as in the results, the teams were created with individuals possessing the same skills, knowledge areas and presented the same attitudes and types of personalities. While it is remarkable that to increase the effectiveness of the team, it is desirable that the team members should be diverse. The diversification of skills and knowledge allows students to share their roles accordingly and assign different types of tasks to individuals having adequate skills and/or possessing the knowledge to solve certain problem.

The main result that came out of this exercise was that the formation of the groups by the students should be guided by the supervisors, some typological personality tests should be performed in advance, e.g., Belbin (2010) team roles tests.

Moreover, the students should be open minded and look for breakthrough opportunities whilst dealing with problems in a creative way.

4.2   Students team work and motivation

The work of the students during teamwork activities revealed that they required supervision on a very regular basis in order to make progress. If not adequately supervised, the team members had a tendency to procrastinate and their motivation dropped significantly which meant that they were not able to resolve all outstanding issues when the project was close to the end of the semester. Therefore, as the outcome of this exercise, we would recommend that supervisors convene frequent meetings to monitor the project's progress and to resolve any conflicts at their initial stage. It is advisable to create a project baseline plan in advance and then monitor the progress towards its execution.

4.3   Supervisors assignment and motivation

The process of appointing a teacher as a supervisor was not as straightforward as formerly envisaged as the majority of academic teachers were already used to the traditional approach of giving lectures, workshops, etc. For them, it involved additional effort and sometimes changing teaching attitudes. Additional problems arose when it came to the adaptation of the subjects to be in-line with the topic of the overall project. Sometimes it meant that some subjects had to have their teaching hours cut while some had to be extended. There were also the additional issues of finding some learning space for project management subjects and team building related ones. That required very close cooperation between the academic teachers and a readiness to compromise, something which proved to be tough and difficult to achieve in some cases.

The outcome from that part is that the teachers who may participate as supervisors in PBL should be differently motivated and put additional effort into their new roles. It is advisable to think ahead about how to introduce a system of incentives.

4.4   E-platform

The SUT currently uses an e-learning platform. However, it emerged that, for PBL purposes, the dedicated software would be more appropriate and effective in use. Therefore, for the purposes of the pilot installation, no e-platform feedback was provided. This generated additional issues in communication and monitoring the work of teams by supervisors. The lack of that tool was not crucial for the pilot's implementation. However, its existence would make information flow smoother and access to data faster and easier to share.

Owing to the above, we would highly recommend investing in an e-platform that supports project-based activities. It could be one platform or a set of software that supports project management, teamwork and data sharing needs.

4.5   Defining the project topics for the courses

The definition of the project topics was of a different nature for each of the faculties. In the Faculty of Automatic Control, Electronics and Computer Science, it was easier to define the topics as some of the subjects were already oriented towards product design. However, the issue was more one of additional funding associated with more comprehensive products at the end of each semester by each team. In contrast, in the Faculty of Organisation and Management, a more important issue was to develop the topic which would be in-line with several different subjects and the funding was not of such major importance.

Therefore, what emerges from that part is that the type of issues related to the projects' topics definition is highly dependent on the faculty area and, in subsequent implementations, it should be addressed in advance.

4.6   Additional funds for courses

As was stated in 4.3, the funding issue was of higher concern in the Faculty of Automatic Control, Electronics and Computer Science, where the project outcomes are mostly

related to products. If we want to diversify the tasks then the final product needs to be more comprehensive and this often necessitates higher costs. It was in contrast with the Faculty of Organisation and Management where project outcomes are most commonly a type of design or proposal of the solution as a set of documents which involve lower operational costs.

However, if further advancement of more courses running on the bases of PBL is to be considered, additional funding issues should be addressed in advance to avoid the potential risk of a project's termination.

4.7   Adapting the semester schedules

While creating the schedule for topics under PBL, the rule is that the lectures should be delivered in large blocks at the beginning of the semester. This differs from the traditional approach where theoretical knowledge is rather distributed throughout the semester, this is especially so in the Faculty of Organisation and Management. That issue was of lower importance in the Faculty of Automatic Control, Electronics and Computer Science, as there are some product design courses already organised in that way.

However, one should be aware that at some faculties, the issue of dramatically redesigning the schedule could be crucial in implementing PBL effectively.

5   Implications for further implementation

Being aware of the limitations of outcomes emerging from the pilot implementations, we could draw up some guidelines regarding the issues connected with future PBL implementation at those universities that have only been teaching the traditional method to this time. The issues we highlighted could be divided into two groups according to timing. One group would comprise of issues which need to be addressed in advance of commencing a PBL course and the second type would be the ones that should be addressed during its execution. The division is shown at the Table 1.

Table 1   The issues related to the timing of addressing them to the PBL courses

Issue	Addressed in advance of the course	Addressed during the course
Team building – TB	X	X
Students' team work and motivation – STUD		X
Supervisor's assignment and motivation – SUP	X	X
E-platform – ePLAT	X	
Definition of the project topics for the courses – DEF	X	
The additional funds for courses – FUNDS	X	X
Adapting the semester schedules – ADAPT	X	

Knowing the factors that should be addressed in advance, we can prepare an action plan needed for preparing the implementation of PBL for new courses.

It seems to be crucial that the issue of staff motivation is the most important one. PBL requires highly motivated teachers who are involved throughout the whole process. In the traditional approach, there is some room for uncertainty in order to deliver already prepared lectures or workshops. However, in PBL courses, the uncertainty level is higher and requires the teachers to be more flexible and proactive in facing new and unexpected problems. It is so because the traditional way of teaching is rather process based, while PBL is more project type and there is always a higher risk associated with projects than with established processes.

The second important issue is team building and teamwork. With the pilot implementation, it was to some extent easier to choose and assign the students to work in teams. For wider implementation, a well-defined systematic approach would be advised.

Additional funds seem to be crucial for the efficient execution of the courses, otherwise their outcomes could be too theoretical or of low product value. That could de-motivate students and the issue of the appropriate final product value is of high importance for industries which are more interested in collaborating with universities on highly practical outcomes. If we would like industry to be involved in PBL courses, (also by assigning additional funds to them) we need to first invest in those courses to show products of real value, something which comes out at the end of each semester to the prospects from industry.

6 Conclusions

Project or problem-based learning was developed as a method of teaching students theoretical and practical knowledge on different courses (academic and non-academic ones). Besides the traditional *student-subject* interaction, it also creates other interactions during the learning process: *team-student*, *team-subject*, *project-subject*, and *project-team*. Each of these new interactions allows students to gain new experiences and skills, both on a theoretical and application level. However, due to its highly practical aspects, the outcomes of each project have to be of real value. It means that product, design or documentation should be created. This is easier to achieve when dealing with non-academic/*technical* courses. One of the major recognised issues at universities is to select the topic of the course which is consonant with its practical outcomes. However, other issues associated with team building and human relations are crucial in non-academic courses as well. Among them, we could emphasise the importance of diversity in teams according to the types of personalities and their skills. It is crucial to set up teams in a proper way and then motivate them on a regular basis throughout the whole project over the course of the semester. Moreover, during the pilot implementations at the university, we recognised that the issue of the motivation of the teachers is one of the highest importance. This was even more salient at those universities where the knowledge was transferred in the traditional way only, the resistance of staff to PBL seems to be higher. Therefore, at such universities it is crucial to create an adequate system of incentives that would motivate teachers to undertake additional tasks connected with this new method of learning. The method's execution is connected with higher uncertainty and creates new types of challenges both for students and teachers alike.

Furthermore, solving those issues very often requires higher flexibility, creativity and a greater level of involvement than in the traditional way of teaching. We can assume that the major roadblocks for successful implementation of PBL are in the psychological sphere in respect to both students and teachers. It requires a new and innovative approach to the learning process.

Moreover, it seems that PBL courses need additional funding at their start-up in order to be run effectively and to show real value to industry. Through the creation of real value products, so-called *PBL students* would be more attractive to employers and, as a result, would place the university on a higher ranking according to the students' willingness to enrol on it and for industry to participate in PBL courses directly, including their co-funding.

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