Educating in Project Management: an innovative approach. A shared-experience among Spanish Universities

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Abstract*: This work presents an educational formal initiative aimed to monitor the acquisition and strengthening of competences by students that are being taught in project management subject. Groups of students belonging to three universities, embracing different knowledge areas such as engineering, biology, etc., were selected to run the experience. All of them had nevertheless a common and basic starting point: inexperience in project management field. In this scenario, we propose a new theoretical and practical approach oriented to reinforce problem-solving and related competences in a project management subject context. For this purpose, a Project-Based Learning (PjBL) initiative has been specifically designed and developed. The main idea is to bring a real-world engineering project management case into the classroom, where students must face up to a completely new learning approach –groups in different locations, collaborative mode and unspecific solution, supported by a powerful internet platform:.project.net (http://www.Project.net). Other relevant aspects such as project climate, knowledge increasing, have also been monitored during the course. Results show and overall improvement in key competences. The obtained information will be used in two ways: to feed the students back about personal opportunities for improvement in specific competences, and to fine-tune the experience for further initiatives.*

1. Introduction

1.1. Project-based learning approach

Teaching project management to engineering students is, in many cases, a challenging matter for the instructors. A main reason can be found in the fact that traditional teaching methods seems not to be the most appropriate ones when considering the subject specificities. In Spanish engineering schools, students have been used to a well-established problem-solving approach. Basically, it consists in providing a single and only one right solution to a specific and detailed technical problem. After years of training in this way, new teaching approaches need to be considered, aimed to project management concepts acquisition and specific competences development. This is mainly due to a common characteristic of this subject: the often highly undefined nature of the client's requirements and the multiple solutions that can be considered. An added difficulty is the length of the course, just 6 ECTS; a short time considering the lack of experience of the students.

In order to cope with such restrictions, some formal approaches have been proposed. Research has shown that students retain minimal information in the traditional didactic teaching environment and frequently experience difficulty in transferring the acquired knowledge to new experiences (Schmidt, 1987).

On the contrary, project-Based Learning (PjBL) environment enables students to draw upon their prior knowledge and skills, bringing a real-world context to the classroom, and reinforcing the knowledge acquired by both independent and cooperative group work (Schmidt, 1993). A search in the literature shows that the researchers have even found interesting the analyses for estimating the effort of both students and instructors in a competitive collaborative environment based into the PjBL strategy. Moreover, specific software tools have been proposed for formalizing the cooperation between teams not located at the same place (Crespo et al., 2011).

1.2. Social Responsibility at the University

Focusing on the students as a main stakeholder, the strengthening of personal competences has turned into a key issue under the new social responsible oriented governance models at the Industrial Engineering School of Madrid. This strategic vision has been reflected in its official document *Social Responsibility Report 2007-2009*. This report is remarkably the pioneer one in the Spanish university context, standing out the way that objectives have been defined, overall scope, applied methodology and commitments. This approach is shared in essence with the other universities participating in the experience.

Additionally, the current implementation in Spain of the new educational model –established by the Bologna process in the European Higher Education Area (EHEA)– has brought to life a prolific framework of innovative educational initiatives (Ivaniskaya et al., 2002; Schoner et al., 2007).

In this context, an innovative initiative is presented, an experience based on the usage of Web 2.0 tools, a technology that opens doors to new fields for ample user collaboration (Moursund, 1999), in the project management learning area. The goal of this experience is to develop a Bologna oriented learning framework for effectively teaching the basics of project management to grade students with no prior experience, and the added difficulty of doing so under a competitive context, as these students are simultaneously attending other course subjects. In order to achieve that goal, an approach that combines theoretical contents, individual applied tasks, usage of software systems and a strategy of project-based learning by doing it is proposed. More specifically, the interest of this experience is to provide basic project management competences by following a monitoring and evaluation approach.

A previous work (Cobo-Benita et al., 2010) already tackled the difficulties of estimating the effort of both students and instructors in a competitive collaborative environment. The present paper focuses on monitoring the aspects related to the management dimension as well as to improve the e-learning capabilities and the global performance of the system. Different time base analyses can be performed by gathering data evidences stored into the software systems. Moreover, the experiences aims to enhance other management competences such as those related to leadership, negotiation and communication.

Next section presents a brief review on related works, followed by the methodology used and the technological aspects involved in the experience. Results section is oriented to describe the rubric design process and finally, last section shows the conclusions obtained up to now in this on-going experience.

2. Theoretical Framework

Problem-Based Learning (PBL), where student's activities are structured around solving open-ended problems, has proved to be an excellent method for developing new forms of competencies (Graff and Kolmos 2003, Kolmos and Kofoed 2002). Project-Based Learning (called here PjBL to distinguish it from the acronym for problem-based learning) follows a similar pedagogic approach than PBL, but its organizing principle is one or more open-ended projects. A PjBL environment enables students to draw upon their prior knowledge and skills, brings a real-world context to the classroom, and reinforces the knowledge acquired by both independent and cooperative group work (Schmidt, 1993).

Research has been focused too on the context that facilitates and supports the motivation and implementation of PjBL (Lam et al., 2010), as well as in the use of the PjBL approach on scientific teaching (Cavanaugh and Dawson, 2010). Rashid et al. (2009) proposed a project management approach used in a multilevel scheme by promoting an integrated framework for diffusion on distant learning. The framework is based on an integrated systems-engineering approach in the light of the diffusion of innovation theory utilizing techniques of project management and Blooms-taxonomy.

PjBL is an interesting alternative as well in capstone courses where the innovation comes from the interdisciplinary nature related both to the instructor and to the students (Rhee et al 2010).

Moehr et al. (2004) provided different solutions in the context of distant learning strategies, including valuable discussions. General references on the usage of Web 2.0 software tool for PjBL can be found in Graaff et al. (2003). Mehvar (2010) studied the procedure related to synchronous distant learning. Technological approaches have explored as well the agent-based field for improving the current distant teaching approaches (Bouhadata and Laskri, 2008).

The recent experience conducted presents some significant differences from the aforementioned works, resulting in an innovative, value added initiative. Firstly, students do not work in a lab-controlled environment, but in other one in which creativity and teamwork is essential to address an open-ended solution. Secondly, the experience is more focused on the project management discipline, rather than the specific problem to solve. Finally, the learning process aims at enhance the acquisition of competences that have been identified as relevant by the practitioners of the field, as remarked by the International Project Management Association (IPMA) (Caupin et al., 2006).

3. Methodology

3.1. Designing the Experience

The approach followed in the courses of the different universities involved (Technical University of Madrid –UPM–, University of León –ULE– and University of La Rioja –UR–) is structurally similar. The course begins by asking the students to propose the definition and configuration of a solution to the problem to solve. It must be ensured that the situation proposed allows multiple solutions, the need of multicriteria decision making processes, milestones, different technologies and disciplines to be considered, etc. In brief, that it complies with the criteria of the CIFTER model (GAPPS, 2006) to evaluate the complexity of a project.

The project manager (PM) has the responsibility of organizing the work and leading the team. It is chosen after estimating the leadership features of the candidates by means of the Blake and Mutton test, the negotiating skills by using the NEGO test and the negotiating style by using the DECTI test. The results of their personal tests are provided to the students so that they can choose their best PM at the kick off meeting according to their initial skills.

Once the PM is chosen, he must define the work breakdown structure (WBS) and negotiate with the other teams –the contractors– their participation according to the scope that it is being defined. The PM also assigns the different tasks to the rest of the members. The performance of the team is monitored on a weekly basis through the software-based support system. The minutes of the meetings and the evaluation of the team members made by the PM are supervised as well.

The instructors support the students' teams playing a role of technical, management and IT consultants, facilitating a smooth process workflow during the course as well as regular analysis based on performance and learning progress.

At the end of the course, a presentation is required in order to show the results to the client, namely the instructor. The most relevant aspects of the experience have to be remarked, especially the project's main strengths and the most important conclusions obtained by the team, related to the development of the experience itself.

3.2. Selecting the software platform

Regarding the selection of the most appropriate web tool, main objective was to provide to the students with the best common platform for ease the collaboration, communication and interaction among them.

The following parameters were taken into account in order to choose the most adequate software environment. They are, in descending order of relevancy:

- ePMO (Enterprise Program Management Office)
- Collaborative multiuser Web 2.0 environment
- Open-source
- Number of collaborative tools provided (Blogs, wikis, forums, automatic e-mail reports, document repository and forms to name a few)
- Real-time supervision of the work developed by the students and forensic analysis
- Performance logs
- Security management, roles and permissions
- Usage flexibility
- Multiple business capability in the same application
- Management of multiple projects
- Intensive use capability, with about 200 hundred students on the experience
- Documentation management
- User and administrator documentation provided
- Workflow
- Simple resource assignation
- Broad range of reports for the project supervision
- Ease of communication channels between virtual businesses

According to these parameters, the software environment selected was Project.net (http://www.project.net). This software facilitates the students the use of the different roles that coexist in the management of a project, enabling the team members to communicate and work together even though they might be located at distant locations.

3.3. Implementing the experience

Within the web platform environment, each company or group of students must generate its own project and must define the tasks to work on, as well as assign resources, define task durations, so that the total length should be equal to the time available for each student.

The collaborative tools provided by Project.net have been used as follows:

- Wiki: knowledge database.
- Blog: where team members have access to record activities performed or tasks completed.
- Documents: repository of documents with a versatile document management system.
- Discussion groups: used as a communication channel, allowing the team members to consolidate ideas, points of view, and thoughts as well as to share their questions with other team members.
- Automatic e-mail notification for a quick transmission of the information to the whole team.

As PM work concerns, a global view of the project is shown at any time in project.net just in one screen (Figure 1), allowing him to check the key performance information on the status of the project, i.e. resource load, scheduled tasks, meetings and so on. This also helps PM to focusing on specific problems, if required.

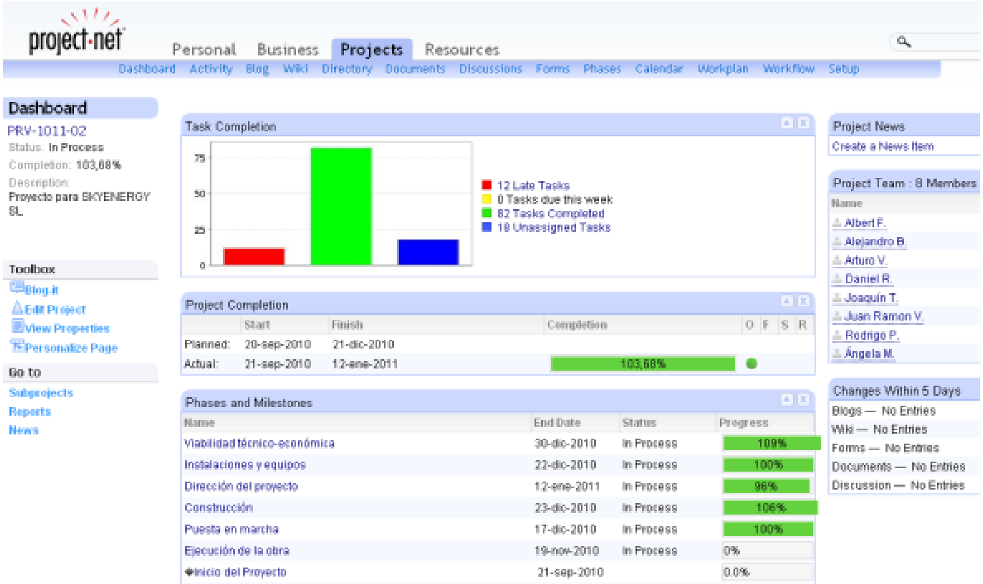

Figure 1: Global view for an on-going project

Regarding the rest of the team members, each student should report, using the software-based support system, the time dedicated to each task, giving as a result the total number of hours the student dedicated to this experience. This provides a log of the progress made and the time consumption for every task.

A number of classical tools (Work Breakdown Structure, Gantt chart, resource assignment), for planning and monitoring the project are available as well, in order to support the PM decisions (Figure 2)

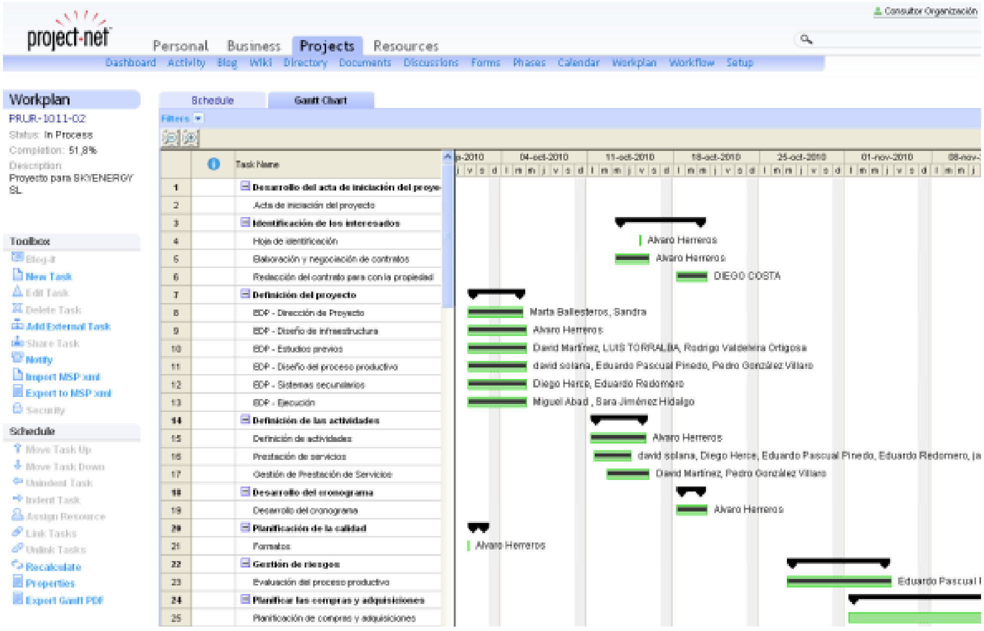

Figure 2: A project planning view

Indeed, instructors are able to get relevant information from the system, on a comparative basis, which permits a continuous evaluation of each specific project and student.

3.4. Competence Model

The framework used as a reference for competences was the IPMA Competence Baseline (ICB) (Caupin et al., 2006). This is the common framework document that all IPMA Member Associations and Certification Bodies abide by to ensure that consistent and harmonized standards are applied. In order to meet the needs of those interested in the practical application of the ICB, the certification process is described for each level, together with a taxonomy and a self-assessment sheet. Professional project management is broken down into 46 competence elements that cover the following aspects:

- Technical competences for project managers (20 elements)
- Behavioural competences for staff members (15 elements)
- Contextual competences of projects, programmes and portfolios (11 elements).

Sixteen competences will be evaluated as a first step of the initiative. This limitation is due to the short duration of the course, just 4.8 ECTS (european credit transfer system), which imposes restrictions on the dedication of both instructors and students. Platform high potential to access to a great number of key performance indicators, allows the instructors to consider further competence assessment schemes. In any case, the competence model of reference is considered adequate.

4. Results and further steps

4.1. Designing the rubric

The evaluation process aims at considering many different dimensions. It makes use of a rubric oriented to measure the improvement in both the transversal and specific competences. As far as the transversal competences are concerned two different kinds of competences are considered: those related to leadership or the capacity of adaptation to new scenarios –systemic competences–, and those related to the capacity of analysis and synthesis, oral and written communication, information management skills, problem resolution, etc. –instrumental competences–. Amongst the specific competences, those related to the capacity of organizing, planning and controlling the project are considered.

To determine the performance on each of the individuals’ competences, different indicators and achievement levels have been established for every role: defective, acceptable, expected, optimum. The evidences related to these performances are collected by different means (Work Breakdown Structure (WBS), minutes of the meeting, etc.).

Achievement levels reflects a maximum score if all the factors are positively achieved. Competence weight is different for project managers (PM) and team members (TM) (Table 1).

4.2. Further steps

Based on this first draft of competences rubric, the following step is to contrast it with the recent just finished project team works. By doing this, the instructors will be able to get an overall picture of each student individual performance during the course, not only regarding the technical and theoretical aspects of the subject but the improvement level when considering key personal competences.

Feedback of the experience will be essential in order to improve, adjust and develop future initiatives based on this model. Indeed, auto-evaluation and evaluation between students techniques could be put in practice in order to reinforce other key competences. In this sense, project subject, developed under this new approach, opens a broader field in which innovative experiences can be implemented and assessed.

Table 1: Competence evaluation rubric

	Competencies IPMA (ICBv3)	Achievements levels	Evaluation (Max. Score) PM	TM
Behavioural	Teamwork	Proactive and open relations between Project Management (PM) and Team Members (TM) Project.net Check List : documents, discussion forums, blogs, etc. Shows an overall positive attitude to collaborate with other teams or/and members of the group Shows an overall positive attitude to collaborate with members of other universities Multidisciplinary work has definitively contributed to project success	5	10
	Problem Solving	Proposed alternatives are clear, reasonable and adjusted to client's requirements Sufficient number of alternatives Clear criteria selection Detailed documentation about the chosen alternative	0	20
	Leadership	Assign tasks in a proper manner Overall picture about the project and tasks to be developed Natural authority, respected by TM Tasks assigned are specific, measurable an reasonable in time and cost	5	0
	Commitment & Motivation	Positive attitude to other members ideas and critics Realistic attitude, oriented to problem solving	5	5
	Results Orientation	Continuous search for improvements, main aspects of the project in mind Excellent time administration, according to importance of the issues	5	5
	Negotiation	Oriented to win-win situations, active defence of personal position, respect others ideas Positive attitude to hear and understand other ideas	5	5
	Communication	Effective communication within project team context (13 indicators to check) Effective communication with client (instructor) (9 indicators)	10	10
Technical	Project Objectives & Requirements	Clear specific objectives and client's needs description (3 indicators)	10	0
	Scope & Deliverables	Clear task description on WBS and the dictionary (3 indicators)	10	0
	Time & Proj. Phases	Evaluation at three levels: WBS, Work plan, Project plan (11 indicators)	10	0
	Resource Assignment	Human and material resource adequate distribution (3 indicators)	5	5
	Cost & Finance Manag.	Well structured budget and costs breakdowns, by subprojects, phases and tasks assignments	10	0
	Procurement Manag.	Well-defined contracts, according to technical specifications (9 indicators)	10	0
	Change Manag	Adaptation to changes (6 indicators)	5	5
	Control & Monitoring	Adequate follow-up during the whole process (7 indicators)	5	0
	Reporting	Quality of information and project documentation (12 indicators)	0	35
			100	**100**

5. Conclusions

The combination of a particular methodology and a specific software tool (Project.net) has successfully resulted in proved useful on the following topics:

- There is a boost in collaborative terms on the group dynamics that allows the team members to put into practice specific competences on the project management field.
- The students are required to adopt an active role, as it is them who must solve the problems that continuously might appear along the project development.
- The student is allowed to develop project management strategies similar to those in a professional environment, and the rest of the team members are able to evaluate the management by means of a continuous supervision. Specific competences for project managers are centric as the IPMA model was selected for designing the methodology.
- The student can work at any distant place and keep contact with the rest of their team members.
- Specific management for virtual teams are used both, for negotiation phase as well as for tracking the evolution of the agreed subproject, including mandatory remarks, etc.

The correct use of the collaborative tools is essential for the success of the experience. The web tool is no longer an e-learning platform but a natural medium with which it is possible to learn, communicate, gain knowledge and share the acquired knowledge in an effective manner.

In spite of the short length of this course (4.8 European Credit Transfer System or ECTS), its closeness to professional practice allows to improve the competence of the students as well as their empowerment as they produce, usually for the first time, an answer to a complex engineering problem.

This teaching model is in harmony with the strategies defined in the Bologna process to develop the EHEA because it is based on achieving specific knowledge according to the degrees involved, and developing the skills required for performance of professional duties and respond to the work challenges of a globalised society.

In the end, it was possible to develop this experience thanks to the selected software-based support system and its functionality, including the traceability for all the decisions, actions, documents and discussions.

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Acknowledgements

This paper has been written in accordance with the works related to the Spanish Ministerio de Educación project with reference EA2010-0001.