The use of computers for graduate education in Project Management. Improving the integration to the industry.

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Abstract - *This paper presents an initiative for monitoring the competence acquisition by a team of students with different backgrounds facing the experience of being working by projects and in a project. These students are graduated bachelor engineering are inexperienced in the project management field and they play this course on a time-shared manner along with other activities. The goal of this experience is to increase the competence levels acquired by using an structured web based portfolio tool helping to reinforce how relevant different project management approaches can result for final products and how important it becomes to maintain the integration along the project. Monitoring is carried out by means of have a look on how the work is being done and measuring different technical parameters per participant. The use of this information could make possible to bring additional information to the students involved in terms of their individual competencies and the identification of new opportunities of personal improvement. These capabilities are strongly requested by companies in their daily work as well as they can be very convenient too for students when they try to organize their PhD work.*

Keywords: Project based learning (PjBL); interdisciplinary learning; computer based approach; competence development in project management; industry oriented learning methodology.

1 Introduction

Teaching project management (PM) to graduate engineering students is, most of the times, a challenging matter [1]. This is mainly due to the well-established approach to problem-solving that the student already has developed after years of training on detailed technical problems –very well defined and with only one right solution available–. Leading with this theoretical approach to problem-solving by asking the students to meet client's requirements develops a new approach to problem solving due to the highly undefined nature of the client's requirements. An added difficulty is the length of the course, just 129 hours of student's work (4,8 ECTS), which becomes short time considering the lack of experience of the students[2].

This is not a new problem at all, as different formal approaches have been proposed to cope with it. Problem Based Learning (PBL) has proved to be an excellent method for developing new forms of competencies [3][4]. 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 [5].

The actual implementation in several European countries of the new educational model –established by the Bologna agreement– has brought to life a prolific framework of innovative educational initiatives [6].

A Project-Based Learning (called here PjBL to distinguish it from the acronym for problem-based learning) 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 [6]. 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 [1][6]. Moreover, specific software tools have been proposed for formalizing the cooperation between teams not located at the same place [7].

It must be ensured that the situation proposed allows multiple solutions, the need of multicriteria decision making processes, enough milestones to consider, and that it involves different technologies and disciplines, etc. In brief, that it complies with the criteria of the CIFTER model [8] to evaluate the complexity of a project.

The main goal of this paper is to present a course configuration that allow the cooperation between different students from different universities, working together in common initiative, allowing the competition between project teams. Indeed, the interest is to go further being able to monitor and measure the management attitudes and capabilities shown by the team members and project management team. This is a key factor in their learning process and makes it a real difference, as feed-back for improvement is given.

The organization of the paper is as follows: in section II the project management competence framework used is presented and globally described. In section III the course itself is presented. According to course characteristics, the software tool implemented and customized is described in section IV. In section V the analysis of the experience is carried out, including the measuring system implemented and

the perception of the students with the whole system. Finally, a conclusion section tries to summarize main aspects involved and potential exploitation for additional uses than those presented here.

2 PM competence model

The terms competency and competence are becoming increasingly used by project managers in conversations around selection or development of project managers. Although the twin ideas of competency and competence frameworks first emerged around 25 years ago, their adoption within the project management profession for various purposes continues.

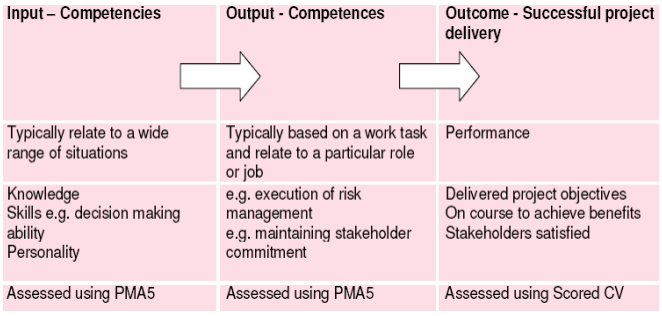

Figure 1. Relationship between competency, competence and project outcome (source [9]).

So competencies could be considered as the underpinning knowledge, attitudes, skills and behavior that an individual needs to acquire to deliver superior performance. In the case of this paper the interest is to be able to measure competences, as they can be collected from evidences recorded with the project management information system (PMIS).

According to previous concepts, the framework used as a reference for competences was the IPMA Competence Baseline [10]. The IPMA Competence Baseline is the common framework document that all IPMA Member Associations and Certification Bodies abide by to ensure that consistent and harmonized standards are applied. 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:

- **technical competences** for project management (20 elements);
- **behavioral competences** of project personnel (15 elements); and
- **contextual competences** of projects, programmes and portfolios (11 elements).

Even when length of the course itself is very limited, which imposes restrictions on the dedication of both instructors and students, it was considered a quite challenging experience from different points of view. Only a few of competences are being assessed, but, in any case, the model for competences of project managers is being considered as adequate.

3 Course Description

During the design of the course organization, it was necessary to to consider some facts. First of all, it is the general lack of student's practical experience in the field. Normally, students come with strong technical knowledge for specific technical aspects as they were trained for solving well defined problems or parts of small projects by splitting the scope of the work on an initially well established and not modified plan. Usually, their experience was gained across different courses, by teams of four of five students.

Additionally, it was decided to establish a more realistic framework in different ways such as customer's scope changes or not fully restrained description of the customer requirements. Indeed, the first job of the students is to identify and discuss the scope of the project as well as its deliverables. Also the communication issues need to be properly addressed, not only inside the team but also with other agents of the project. Thus, for example, project teams are requested to deliver a flash video file presenting their proposed solution to the customer's request.

In order to be closer to the reality it was decided to populate the project teams with members (i.e. students) running project management courses at the same time in different universities. This was a challenge because not all the universities start the academic year at the same time, students background is very different (environmental engineers, industrial engineers, mechanical engineers, electrical engineers, etc.), they are located far away in different places (in this particular implementation four courses from three different universities were merged) and they have different internal schedules which raised different organizational difficulties.

Obviously every course at each University has its own programme, according to the specific objectives of the degree involved. That means that different students from different courses and Universities will learn theoretical concepts at different time or speed and the practical work carried out under the presented approach makes possible the reflective learning [11][12] as some of them becomes aware about the reason for some mistakes they performed when the theory is discussed in the classroom.

The shared component for all of these courses is the practical project to be developed. It means about 1400h of work, to be developed during four months by teams of about 40 students each one. The resource allocation always becomes a problem and, even when it is expected that all the students make managerial activities as well as technical work inside those activities, the figure of project manager is selected by self appointment, after a number of surveys per team member were performed. These surveys inform the student about his/her leadership orientation, his/her profile as manager, etc.,

in such a way that a formal presentation is made, like candidatures to be appointed for project manager by all the teams.

The complete practical work was monitored, troughout regular surveys, as shown for example in Figure 2. Several questions are raised to the students on a two-week basis. Most of them are focused to identify perception about the project, their own role in the team, the workload, and conflict identification or information about properly project development.

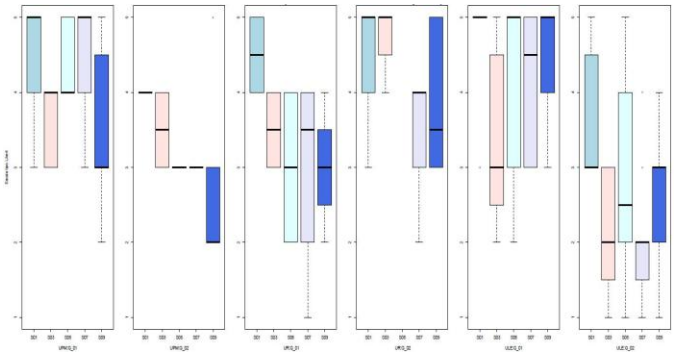

Figure 2. Result of the survey question about the perception of the project climate along the time. Each block is related to one project team. Inside each block two week period perception is depicted.

This way it is possible to identify the underlying model –between multidisciplinary or truly interdisciplinary– that each team implemented [13]. Furthermore, in some cases, it becomes an indicator about internal or organizative problems in the team.

4 The selected software tool

In order to address all the features identified in previous section, regarding the course organization, strong IT skills are required from all the team members, as they are kindly requested to not only perform the technical work but also to update the managerial status of the work, as well as to discuss technical issues of the work being done with other involved team members located in other universities. It is also required that as much activity as possible become available for analyses, in order to provide feed-back to the student about how to improve or how to do better.

Different technical solutions are available but additional factors like cost must be considered carefully, because about 600 students from different Universities per year are involved in this experience and there is no an easy task to have common agreements for buying software licenses available at different places with different IP addresses. Regarding the type of software, as it is required to manage between 10 and 15 simultaneous projects, it seems quite clear that a portfolio management tools is required.

The selected software environment was Project.net (http://www.Project.net) as it has a community version available under open-source license type. The installation was performed in the data center of one of the participants and all the students of all Universities become enrolled on this system.

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 [14].

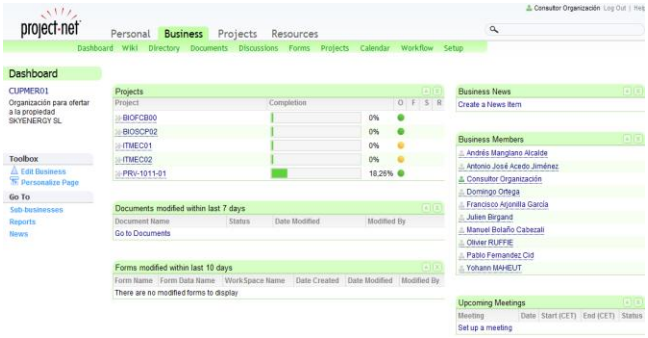

Figure 3. Different projects launched by one team inside one business.

The tool allows presenting a global view about the project, providing to the Project Manager (PM) the main issues requiring actions.

Figure 4. Global view for one running project.

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.

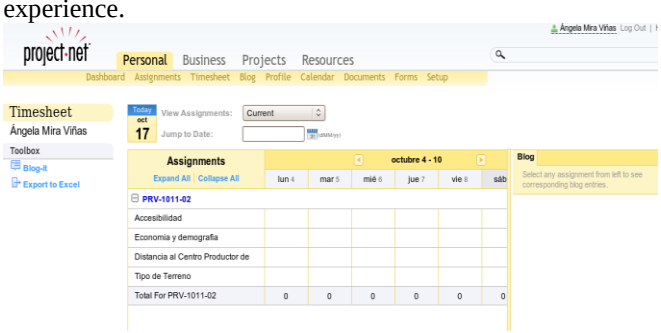

Figure 5. Detail user's view for timesheet control page.

It is possible to make the project plan picture with tasks, relationship and percentage of improvement.

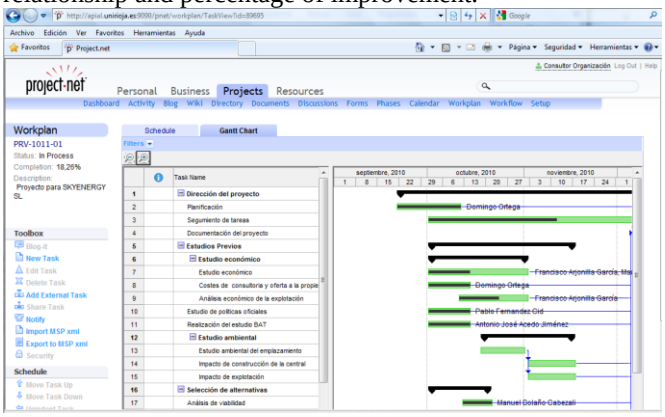

Figure 6. Planning and Monitoring view for the project.

Or even take a detailed look over the project on a task per task approach.

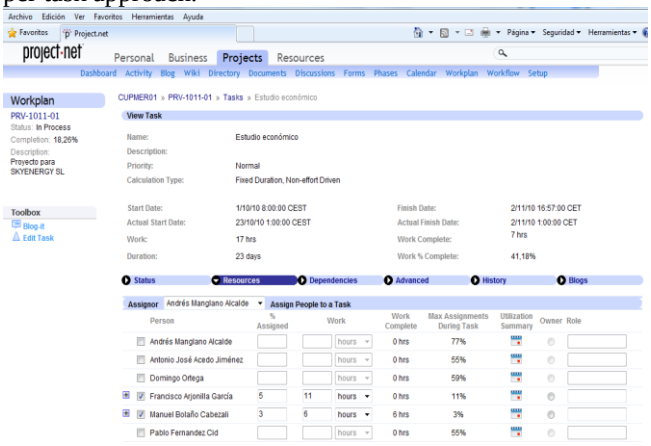

Figure 7. Detail view for one task.

Indeed, for learning purposes, it is possible to carry out a forensic analysis of decisions adopted, as shown in Figure 8. It is possible to review different versions of one document as well as the claims for effort submitted into the relevant task and how the task's product was linked to it.

In addition it is possible to qualify the discussion held between the user of a task's product and their customers (other team members in other relative tasks), as well as the decision made by the project manager.

All that information is regularly collected by the system and it is processed in order to better analyze different student approaches to project management.

Monitoring teachers are in charge of perform these analyses as well as for doing formal audits (twice per semester) where the result, both global for the project as well as detailed per team member is disclosed.

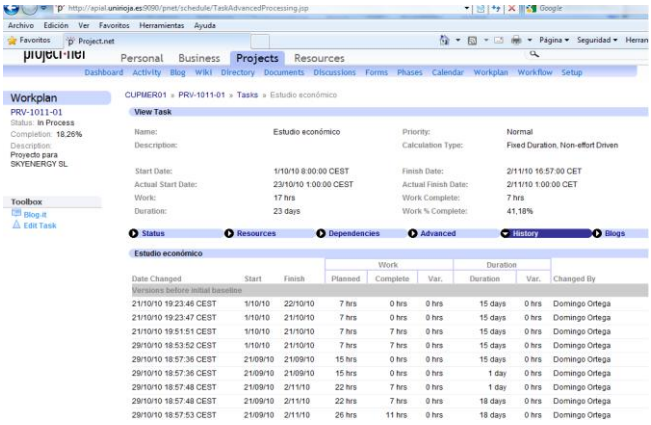

Figure 8. Historic view of changes introduced into a single task. It is useful for forensic analyses.

5 Analysis of the experience

The students acquire the competences not only through the traditional channels but also by the interaction amongst them while using the collaborative tools that Project.net provides. Indeed, there are aspects of the organizational culture that endows the students with a formal work methodology that makes them accustomed to think about what must be done and what effort must be made in order to achieve a specific goal. Moreover, as the deliverables obtained by some members might be inputs in the processes assigned to others, the dependency and connectivity of the task is usually very significant. The software-based support system itself promotes the traceability by allowing multiple versions and complete data.

According to the IPMA competences for project management, the technical competence 1.10-Scope and Deliverables is presented by a Work Breakdown structure (WBS) and its dictionary uploaded as documents to the file directory area. PM is responsible for defining project phases as work packages. For each WP a list of deliverables is identified and declared (see Figure 9). Per deliverable, a list of tasks is identified, and pert task resources are identified and assigned (IPMA Compentece 1.12). All these steps need to be maintained but the system makes possible to monitor its traceability and to assess these PM competences.

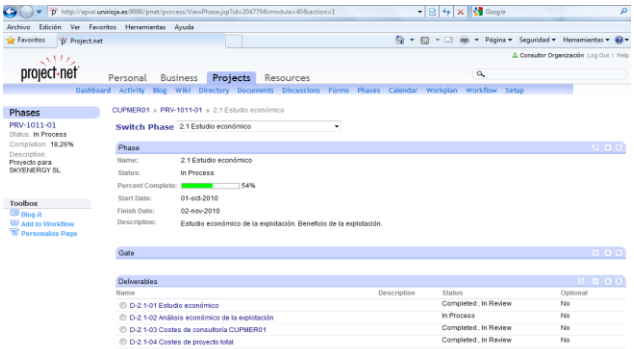

Figure 9. Phase definition with deliverables declared

It is possible to have a detailed view over different parameters along its developing period. Some of them are presented at Table 1, according to the IPMA codification.

Competence	*Parameters*	*Period*
1.02 Interested parties	Number of formal minutes of meetings agreed with customer	4 times
1.04 Project requiremens & objectives	WBS definition, rastreability matrix, List of deliverables and consistent task definition	1 time
1.06 Project organization	Number of WP, Tasks and deliverables	2 times
	Number of work hours initially scheduled and finally claimed	2 times
1.05 Quality	% of deliverables linked to documents and % od deliverables formally approved	6 times
	Averaged quality for deliverables	3 times
1.07 Teamwork	Evolution of standard deviation and average of climea survey.	6 times
1.09 Project structures	Team architecture defined, including formal management and audits	1 time
1.11 Time & project phases	Gannt diagrams and their management, including corrective actions	6 times
1.13 Cost & finance	Negociated budget against number of hours used by team members. Comparison according to EVMS methodology is performed	3 times
1.15 Changes	Amount of PM corrective actions implemented along the project	1 times
1.16 Control & reports	Differnece between reported situation and evidences coming form the software tool by auditing processes	3 times
1.17 Information and Documents	Perception between the selfassessment and the evaluation carried out by product users	3 times
1,18 Communi-cation	Quality of messages delivered by the video as well as its organziation and resources used	1 time

Table 1. List of Parameters related to technical competences monitored according to this proposal

Indeed many other competences are considered but less formal monitoring approach is used, like self-control, motivation, negotiation creativity and ethics.

On these competences only indirect evidences are recorded and, because of that, only suggestions are raised as feed-back to the participants.

Different phases can normally be observed during the experience. Initially, students do not believe possible to manage such under-defined proposal and they look for common understanding of the problem because they come from different environments. During this phase several meetings are held with the customer (some teachers playing that role).

Next, they face learning problems regarding detailed management of the platform and specific coaching actions from the project manager team is required to put everyone on the rails.

Later on, student teams realize that some of the initial hypotheses made are not longer valid and scope redefinition is requested (change management) but the deadline is fixed. Because of this, the pressure increases and the stress too. These effects are amplified because of the distance and the different background of the team members. This period is quite convenient in order to monitor the leadership qualities of the project manager.

Sometimes, because the differences in course organization in different universities it is possible to identify wrong approaches to different issues. In these cases, scenarios of learning from mistakes occur and it becomes necessary to carefully explain to them that this effect is, in fact, an interesting opportunity, because they become really afraid about wasted time.

Regarding the experience itself, students scored it really well as shown in Figure 10. In this figure all the student answers from different degrees and Universities were considered and answers were graded from 0: fully disagreement to 5: fully agreement. The anonymous survey is runned once per semester and the last week of the course. This survey also is focused on perception about their competence adquisition during the course.

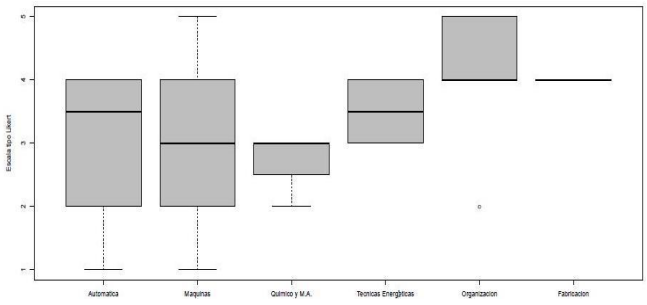

Figure 10. Student perception for the presented experience. Groups are for different student's degree and asked question was "Do you feel the practical experience of the PM course provides you with valuable skills as well as with toolset and knowledge useful in the industry?"

A number of additional questions were surveyed helping teachers to get better understanding about the student perceptions as well as about how to improve the experience. In this particular edition (course 2010-2011) a clear demand was to increase the managerial activities for all the participants, instead of concentrate them in the project management team.

A learn lesson from the teachers team was try to produce a common view for the evolution of the different projects and, in order to making it happening, additional and automatic reports are requested in order to have more common an detailed views for the project. This will produce a more detailed and evidence supported report status which will improve the unification of diagnostics, instead on being dominated for distinct and different perceived particular aspects.

6 Conclusions

The experience presented here show us how, by using computers as a common tool, different cooperation initiatives between different students in different universities and in different places work all together under a collaborative learning approach. This collaborative effort is just a new way of learning by doing and it is combined in different ways at every participant university.

In spite of the lack of previous experience of participants and the limited time frame available very good organizing capabilities have been acquired by participants, regarding not only the rubrics for every curse but also the parameters established for monitoring the performance on specific project management competences. These competences are the key ones for practical work at the industry according the IPMA association and that makes an added value to the initiative.

The individual effort is monitored as well as the decision made inside the project and explanation according the theory is sometimes requested. Different challenging but common factors are also addressed, like multicultural resources, 'virtual' teams, real scope including scope changes and time & budget constraints. Feedback is provided to the participants regarding the auditing capabilities of the software tool selected and the parameters identified as relevant. Additional surveys regarding project climate and feelings are carried out in addition to the normal work.

As main conclusion, students support the experience as they perceive like a reality immersive approach allowing them to acquire specific skills. In addition they remark the adoption of specific work methodology allowing them to integrate the work from others. To this particular field they agree with the tool used as they find it has a friendly web interface for collaborative work as well as powerful enough for helping them in the project management.

Teachers found very convenient the auditing information provided by the software as they are able to provide feedback to the students regarding that specific data. In this area it was found very convenient to measure individual parameters as indicators for student's competence performance. Specific statistical analyses will be possible in the future, when enough data become available.

It is found that this methodology becomes useful for students not only at graduate level, and not only for project teams but also for specific research projects. Additional analyses regarding added value is being performed before extend its use to PhD students, in an effort for providing them with a specific methodology for management along their own path but also in order to collect systematic information for the process itself. In this case a combined approach between process improvement and data mining could be beneficial because it can provide detailed as well as statistically relevant information about problems or bottlenecks or even wrong designed subprocesses.

Acknowledgment

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