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Student Groups Solving Real-life Projects. A Case Study of Experiential Learning*

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A Project Management (PM) training approach is presented based on the solution of real-life projects by groups of students in their last year at the School of Engineering of the University of Zaragoza. The training dynamics simulates the functioning of a consulting firm, where students are the consultants and the teachers work as mentors, sharing a common methodology to help the student groups to successfully bring their projects to completion. The 'problems' to be solved are proposed by real customers. During the academic years 2003/04 and 2004/05, 41 customers and 240 students have taken part in the course, with very satisfactory results. With the ultimate goal of increasing the satisfaction of all participants in this course, our priority has evolved in this period and we currently seek to ensure that no project group ends in failure. The results of this experience are based mainly on the analysis of 'failed' groups (5 out of 41 cases), the periodic group self-assessment sessions and the feedback received from students. According to this research, coordination within a project group appears to be a key aspect in influencing the results obtained. Those groups with an assigned 'coordinator' worked better. It is also worth pointing out that, as the project advanced, it was noted that all of the groups felt more confident and more optimistic about the quality of their work and the level of satisfaction expected from the customer, regardless of the actual results. Also, the vast majority of the groups grossly underestimated the time needed to complete the work. The paper concludes by describing future lines of work and collaboration in the model framework presented.

Keywords: cooperative learning; project management; Project Management Office; experiential learning; newly formed groups

INTRODUCTION

HOW DO WE learn from experience? At the organizational level, a small percentage of what is learned is used in new projects [1]. According to Turner [2], less than 20% of what we have learned in our most recent project is then applied to the next one.

In the business world, real life is the main source of individual learning for new project managers. In the European engineering and construction industries, the established way of learning the job of project management is by working alongside more senior colleagues—by 'sitting next to Nellie', as some say. It is only after a solid foundation of experience has been obtained, that one begins to be sent on specialized training courses [2]. The inexperienced manager learns from his colleagues, bosses and other agents (contractors, users, etc.) associated with the projects in which he participates. His environment nourishes him. During these first steps, he is sometimes successful and sometimes makes mistakes, but he is always learning.

In order to support the growing tendency in the business world to divide the work by projects, a new unit has appeared in some companies: the Project Management Office (PMO). A PMO is an organizational department, devoted to fostering improved management practices and collective learning in relation to the projects that are underway [3, 4]. The availability of a PMO aids the process of learning how to manage projects for the entire company [5].

Over the last decade, the growth of the project-oriented model has been spectacular, as the increase in the number of certified professionals worldwide shows. Macroeconomic estimates value total investments in projects as approximately 50% of total GNP in western countries [6]. Because of this, the availability of people with the appropriate skills in managing projects is a powerful development tool that should be looked at at all levels of society. Educational institutions need to train managers, transforming unskilled personnel into a workforce that is able to support organizations that are wholly or partially project oriented.

With reference to the efforts of educational institutions, Snyder says '. . . . technical competence is a necessary skill, but not a sufficient skill. 'Other' skills that must accompany technical knowledge include the ability to understand how technology fits into the business equation, the ability to communicate, and a breadth of vision, flexibility, customer focus, and business orientation. These are in part developed through broad-ranging student/student or student/staff interaction and communication' [7].

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Generally, universities work with students who, for the most part, have no previous experience in carrying out projects or working in teams. Furthermore, training in a project-oriented approach has hardly been developed in universities. According to Kolmos [8], most universities are not working with this approach. A notable exception is the University of Aalborg, where students spend one of their semesters carrying out a project. The different departments of the University act as supporting actors to help in the development of each project [9].

Project Management is still nascent as an academic discipline. In Europe, there are still very few universities currently offering this type of course in their standard curricula. There are some business schools, however, that are, pursuing this training in Project Management in more depth.

At the same time, 'project based learning' and 'cooperative learning' represent new trends in the teaching of technical disciplines, assigning projects to groups of students with the goal of improving the learning of content [10, 11, 12].

The greatest difficulty faced by universities in training project managers is the lack of a nourishing environment. Few educational centres have allowed their students to learn by managing real projects [13, 14]. Indeed, after having run several searches, the authors have still not been able to find the concept of 'cooperative learning' applied to the teaching of Project Management where real customers are involved.

What follows is the description of the experience in Project Management training carried out at the University of Zaragoza.

FEATURES OF THE PROJECT MANAGEMENT COURSE

During the Autumn–Winter semester (September to February), a compulsory six-credit (5 European Credit Transfer Scheme credits) course in Project Management is offered to students in their last year of the Master in Industrial Engineering of the University of Zaragoza. These students have had no previous experience working in groups or participating in the management of any project and their average age is 23. The course consists of lectures, project group meetings and occasional seminars dealing with different topics focused on helping project group work.

The scope of the work was to prepare a project plan to solve a customer's problem. During the academic year 2004–2005, 7 of the 19 projects assigned were subsequently implemented. For example, one group proposed the organization of a multicultural party for all Erasmus students at the University of Zaragoza and finally carried it out. Of these seven implemented projects, four of them were implemented the semester after the course took place, and therefore the students' final presentation was delayed until the following semester.

TRAINING APPROACH

The training model has been based on the following principles:

- learning obtained from projects carried out for real customers;
- support for students' team working;
- the role of teachers as group mentors;
- Learning obtained from projects carried out for real customers.

The environment created is that of a consultancy company in which work groups provide solutions to the requirements brought to them by clients.

Students join together (so far freely) in groups of six and their first task is to look for a customer. Typical clients are small or medium-sized companies, local government agencies, NGOs, sports associations, individuals, neighbourhood associations and even the University of Zaragoza. Mentors initially focus their efforts on determining which of the various ideas proposed by each group best fits with the project management goals sought in the course.

Since 1989, the Project Engineering Group has been using real companies' needs as the basis for carrying out projects in courses such as Project Engineering, Logistics and Product Engineering. The educational purpose has always been to promote learning by throwing the group of novices 'in at the deep end' while helping and encouraging them to 'keep afloat and swim forward'. The results have always been very positive.

Support to students' team working

Over the last ten years, several initiatives have taken shape in US and European universities in an attempt to provide project groups with a set of tools and knowledge to facilitate their work [11, 12].

Typically, when a group starts up, group meetings, internal conflicts, work distribution and group coordination are issues that pertain to the members of the group alone. The teacher/mentor neither knows of nor participates in proceedings. This was our approach, too: mentors did not get involved in the internal workings of the groups. One may ask why we did not help the group in those soft features of project management, as well. After all, they seem to be related to the causes of failure when failure is the outcome.

When we think of a theoretical topic for a course on Project Management, it is interesting to note that the topics we leave to the end and those most likely to become forgotten in lectures are exactly the ones that deal with soft skills: motivation, group dynamics, communication and time management. In our case, it was the very evolution of the course that pushed the inclusion of these

topics, which had not been previously included in the curriculum, either.

The role of teachers as group mentors

Assuming that the first priority is to provide a service to a customer, all groups will adopt the same working methodology and a working plan. The teachers will act as group mentors. They provide advice, but it is the group that remains responsible for the decisions adopted [16].

Continuing the aforementioned analogy of a consulting company, the group of five teachers act as a Project Management Office (PMO) created within the company to support the development of the projects.

COURSE MONITORING

The monitoring of this course has been based on:

- meetings of group members with their mentor;
- co-ordination of groups;
- work handed in as deliverables and final presentation.

Meetings of group members with their mentor

Throughout the semester weekly half-hour meetings were held between the members of each group and their mentor. Attendance was mandatory for all group members. During the meetings, the following issues were discussed:

- evaluation of the work handed in;
- contacts made with relevant agents;
- problems that had arisen;
- next steps to be taken;
- doubts related to how the work should be carried out.

In higher education, we often miss the chance of reflecting with students on what has been carried out and how it has been experienced by the whole group. In the context of learning by doing, the most valuable moment comes when the work has been completed (in most cases satisfactorily) and then all the participants, group and mentor, can pool their thoughts and ideas to analyse the work performed. However, it may be that no time is available in the course schedule to carry out such a meeting. On the other hand, there is no reason for a group to wait until the project is over to hold a meeting about what they feel and think in relation to the project. As Schindler stated [17]: '. . . a structure that allows for several feedback sessions distributed throughout the entire duration of the project is preferable, . . . due to the motivation it arouses in the group and the quality of the results of the lessons obtained in this way'.

Self-assessment sessions were held with the aim of exclusively discussing topics such as the group's expectations or its internal functioning. At the beginning of this 30-minute meeting, all the members filled out an individual questionnaire consisting of a few questions set by the mentor. He/she, then presented the results to the group and a discussion followed, giving the group members the opportunity to clarify their views on:

- confidence in customer satisfaction;
- the need for improved coordination;
- estimation of the work remaining;
- any help that may be needed.

Three self-assessment meetings were planned throughout the course, interspersed with the weekly seminar sessions. The final meeting took place almost immediately after the public presentation of the project.

Coordination of groups during their work

In order to assure a basic level of organization in each group, mentors focused their efforts on getting across to students the need for:

- holding weekly project group meetings;
- keeping a record of what is agreed (minutes record);
- monitoring the actions agreed in the group, in accordance with the general plan for handing-in of deliverables during the course.

In order to help groups in their work, we have traditionally asked them to record minutes of the meetings, in which decisions and agreements are noted down. The evolution and level of accomplishment of these agreements is reviewed by the mentor at the beginning of each meeting.

Attendance of the entire group at these meetings with the mentor has been deemed necessary, and it has been required in order to stress the pattern to be followed in the meetings the group holds without the mentor.

By asking students to summarize and write down the agreements made, some changes in behaviour were detected: the initially passive attitude of some of the members changed when they were faced with a written commitment to the task agreed upon.

The minutes record, as a document, was managed by groups in very different ways. The fact that it did not enjoy very widespread acceptance may be because no one was appointed to register the commitments and verify that they were followed.

The role of a 'student-coordinator' appeared in some of the groups, but not all of them. During both the 2003/04 and 2004/05 academic years, the mentors' attitude was that group members should decide how they organized the group to achieve their work goals. This approach is currently being revised according to the results presented in this paper.

Work handed in and final presentation

Throughout the course, groups had to hand in three reports and a give a public presentation based on the final report (see Fig. 1).

- First report: Definition and scope of the project (Statement of work)

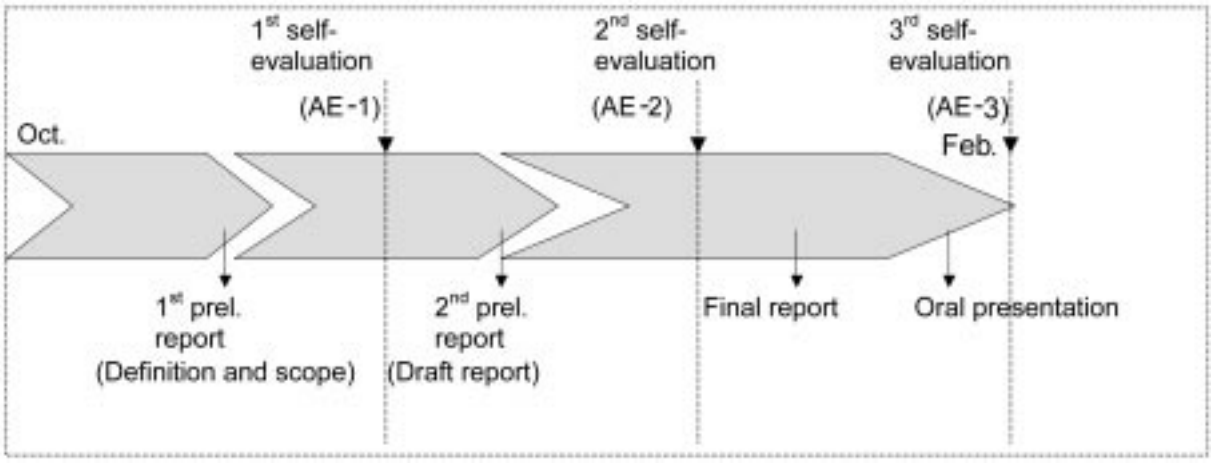

Fig. 1. Course structure.

- Second report: Draft of the project plan
- Final report: Project plan
- Oral presentation of the project in front of a committee formed by some mentors and the customer.

The presentation lasted 20 minutes plus 10 minutes for questions and usually took place about one week after the final report was handed out. The other groups also attended their colleagues' presentations.

THE IMPLEMENTATION OF A KNOWLEDGE MANAGEMENT SYSTEM

The completion of 20 cases with 20 different customers and 120 students every year provides a wealth of experience that is worth analysing. We should not miss the opportunity to capitalize on the results obtained in this 'laboratory' [18, 19].

Our information system registers the data produced during the course. The review of the experiences and information obtained from them has allowed the team of mentors to decide on the measures to be adopted to increase all participants' satisfaction. After many discussions, we can state that our understanding of 'participants' satisfaction' currently means ensuring that none of the projects ends in failure, and therefore this is our first priority.

Mentors also met periodically (approximately four times during the semester) to check on progress made in the course and to agree on the content of the questionnaires to be used in the next self-assessment sessions with the student groups. After the final presentations, more meetings took

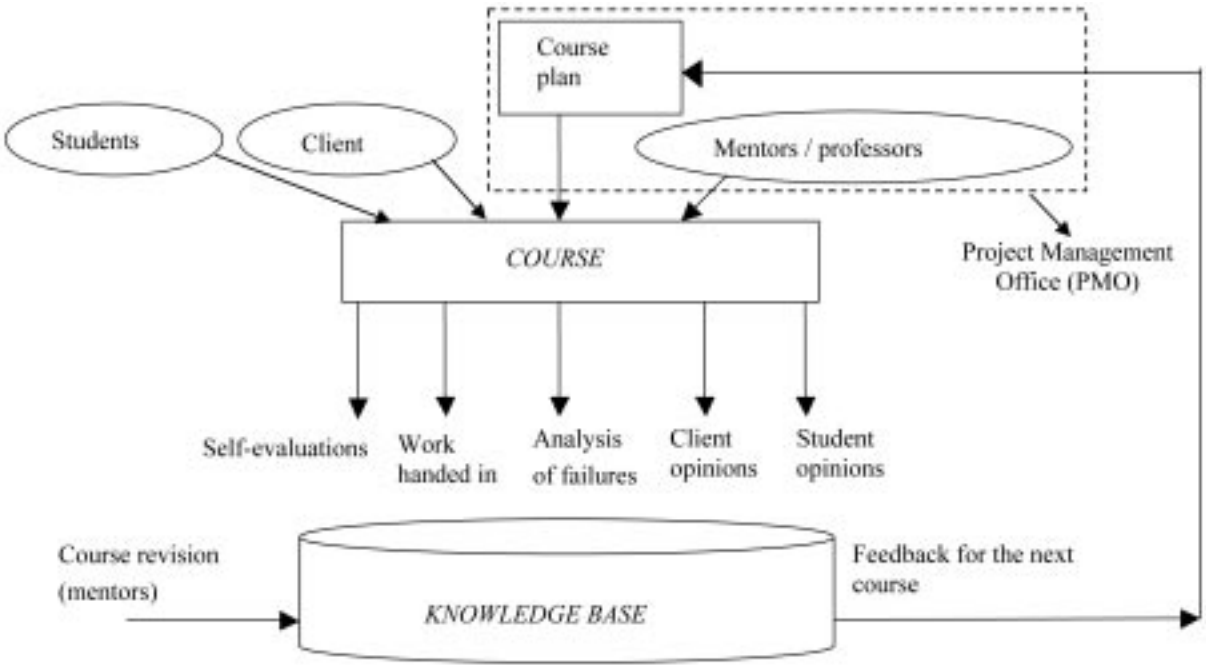

Fig. 2. Model of the knowledge management system.

Table 1. Course feedback by students

Results of the questionnaires	2003/04 year		2004/05 year	
	Average	Standard dev.	Average	Standard dev.
Project work				
Interest in the work	7.8	1.4	8	1.5
Experience of working in a group	7.8	1.8	8.1	1.5
Experience of presenting the work in public	7.7	1.9	7.4	2
Relations with the associated agents (client, administration, etc.)	7.4	1.8	7.4	2
Lectures				
Interest in the lectures	5.8	1.9	6	1.9
Seminars				
Causes of project failure			7.1	1.7
Psychological strategies in teamwork			7.5	1.7
Ms-Project			7.4	1.3
How to deliver a good presentation			7.3	1.5
Global evaluation of the experience	No. of responses	% of responses	No. of responses	% of responses
Highly negative	1	0.8	0	0
Negative	5	3.8	3	2.6
Not relevant	6	4.6	6	5.2
Positive	92	70.8	82	70.7
Highly positive	25	19.2	23	19.8

place for debriefing of the results and to prepare and shape the coming year's course (see Fig. 2).

Learning takes place in this model at different levels:

- group members learn from what is taking place around them and from their own decisions and activities;
- the PMO must act as a learning organization and, as such, it must constantly update itself on the basis of previous experiences.

The information collected on the development of the projects constitutes an important source of knowledge, the study of which should allow us to confirm or reject hypotheses on how to manage newly formed project teams.

Student opinions

At the end of the course, students were asked to individually evaluate the project work through an anonymous questionnaire consisting of four sections, rated on a scale from 0 to 10 (10 being the best): project work, lectures, seminars and overall experience. In addition, there was a final open question section where students could give their comments.

Table 1 shows the results of the first four sections for the courses. 129 students responded to this questionnaire during the academic year 2003/04 and 116 during 2004/05. No rating for seminars is shown for 2003/04 because they were only introduced in 2004/05.

Interest in the project work was high, becoming somewhat higher in the second year. Over 90% of students responded that the project experience had been positive or highly positive. Also, seminars were rated considerably higher than lectures.

Table 2 shows the number of times the most common ideas appeared in response to the open questions: 'What aspects of this course did you find most interesting?' and 'What do you feel most satisfied about?'

'Working in a team' has been considered to be a positive outcome and has been quoted as the most favourable aspect of the course, together with 'having taken part in a real-life project'.

ANALYSIS OF FAILURES

We also had some projects that did not reach a minimum level. The question is: What didn't

Table 2. Answers to open final evaluation questions

Question	Answers grouped by similarity	Times quoted	
		2003/04 year	2004/05 year
Most interesting aspects	Working in a group	34	60
	To act on a real project	59	43
	Presenting in public	22	17
	Being able to work in a group	36	43
Reasons for satisfaction	Being able to carry out a good project	48	44

work? According to Pinto [20], a project can be considered to have failed when at least one of the following has occurred.

- All members of the PMO share the opinion that the results are negative.
- The customer has expressed disagreement with the outcome.
- The development process of the project has not been satisfactory.

During the 2003/04 academic year, four out of 22 projects were considered to have failed. In the academic year 2004/05, two out of 19 were considered to have done so. What happened in these cases? What were the causes? What solutions could be implemented both in regards to group members and to the customer? How could this result have been avoided? What can be learnt to prevent similar failures in the future?

As Terry Williams points out [21], the analysis of all of these issues is a difficult task. In our case, the mentors shared their perspectives on the failed groups based on: the records available from meetings, the work handed in and the opinion of the mentor of the failure group.

Five of the six failing projects were analysed; the causes detected can be summarized as follows.

1. Poor coordination: among the group members to perform the project tasks.
2. Heterogeneous group: the group was formed by 'leftover' students who had not been able to make a group on their own before the deadline.
3. Personal problems in the group: at least one of the members was not willing to collaborate on the project.
4. Scheduling problems: group members didn't share the same schedule and therefore they couldn't find a suitable time for group meetings.
5. Low potential of the group: mentors believe that this group would have had problems regardless of the type of project.
6. Insufficient scope of the project: the project carried out was not ambitious enough to meet the level required.
7. Unacceptable work: the quality of the work performed (deliverables and reports) was not enough.
8. Difficulty of the assignment: overwhelming difficulties were found in the project and/or its environment, for example, from political aspects.
9. Poor communication with other project agents: the group had not established sound communication channels with the project agents (customer, administration, stakeholders).
10. Lack of interest from the customer: the customer's interest in the work is an important drive for the group motivation.

Table 3 shows the causes of failure attributed to the different groups analysed.

'Poor coordination' was mentioned as a cause of failure in three of the five groups analysed. The following causes each appear twice: 'Scheduling problems', 'Low group potential', 'Personal problems in the group' and 'Heterogeneous group'.

At the start of 2004/05 the team of mentors decided to offer a seminar on 'The Causes of Failure in Project Groups', which was scheduled to run just after the student groups had been formed.

Also, in the same semester, mentors began to identify certain groups as 'at risk'. That is, students were informed that the group's mentor had detected certain problems in the group that could threaten the results of its work. Three of the 19 groups were warned that they were 'at risk'.

One of these three groups that was considered to be 'at risk' eventually failed, while the other two reclaimed the situation. Of the groups that were not perceived to be 'at risk', one of the 16 experienced failure.

We are inclined to think that the two groups 'at risk' that didn't fail actually made an effort to get out of the 'risky' situation; the warnings stimulated both mentors and participants to work harder and avoid the foreseen dangers.

RESULTS OF THE RESEARCH

What factors associated with the internal organization of a group affect the functioning and

Table 3. Causes of failure associated with crisis groups

	Group reference					
Causes of failure	04.23	04.17	04.20	05.06	05.01	Frequency
Poor coordination	1	1			1	3
Heterogeneous group			1		1	2
Personal problems in the group			1		1	2
Scheduling problems	1	1				2
Low group potential	1	1				2
Insufficient scope of the project			1	1		2
Unacceptable work					1	1
Difficulty in the topic of the assignment			1			1
Poor communication with the stakeholders				1		1
Lack of a client interested in the results of the work	1					1

Table 4. The impact of the presence of a coordinator in group results

Presence of coordinator in the group	Failure rate (%)	Success rate (%)
With coordinator	10	75
No coordinator	18	59

Table 5. Failure rate and proportion of successes in groups that planned and those that actually carried out the project

Level of implementation of the project	Failure rate (%)	Success rate (%)
Only Project plan	19	61
Project implemented	0	86

efficiency of the project groups? According to Harris [22], the less control and internal norms that exist in the work group, the greater the confidence that is needed by its participants in order for the group to be effective. Busseri [23] believes that if the team is evaluated while it performs its work, it stimulates the group to reflect on its way of working and to improve it. Loo [24] proposes a method for evaluating the working atmosphere of project groups.

The information collected from 37 of 41 projects has been processed in order to identify which factors may have influenced their success or failure.

A failure group receives a grading of less than 5 (in a scale of 1 to 10, with 10 being the best). A success group is a group with a grading of more than 7. We define failure rate as the number of failure groups divided by the total number of groups; success rate is the number of success groups divided by the total number of groups.

Existence of a student-coordinator within the group

20 of the 37 groups analysed had a coordinator. In these groups, lower failure rates and greater success rates were detected than in groups with no such coordinator (see Table 4).

Students' perception of the importance of the coordination in their project results

When students were asked to answer how important they thought that coordination was for their work, their answers were unanimous in grading it very high.

Confidence of students in their work throughout the development of the project

In the two first self-assessment sessions, students were asked about the confidence they had in the customer satisfaction with their work. In all cases, regardless of the results obtained, the students experienced an increase in their perception of the customer satisfaction as the project went on. No group experienced a decrease in confidence.

Evolution of students' confidence in the implementation of the project by the customer

As in the previous case, the confidence expressed by the students in the project implementation increased as their work became nearer to completion.

Difficulty in estimating the work load

On different occasions, students were asked to estimate:

- hours worked so far;
- hours remaining necessary for completing the project;
- actual hours invested in the project.

Taking into consideration that the groups did not keep any control over the hours they worked, it is interesting to see that the time spent turned out to be, on average, 3.6 times the initial estimate. In only one case was the result lower than the estimate (0.7 times) and, in the other groups, work load ranged from 1.7 to 12 times the initial estimate. Almost without exception, the student groups showed excessive optimism when faced with the task of estimating the effort required.

Relationship between the level of implementation of the project and the results obtained

Of the 41 groups formed so far, seven have actually carried out their project, while 34 only prepared a project plan. It has been observed that the results have been better for those groups that have carried out the project (86% success rate) than for those that have only made a project plan (61% success rate) (see Table 5).

FEEDBACK FOR THE ACADEMIC YEAR 2005/06

Thinking ahead to the academic year 2005/06, we have decided to adopt the following measures:

- to train groups to be better coordinated, considering that coordination problems may lead to failure. Recommendations to be made to groups will include: assigning certain roles (e.g. coordinator), or keeping control of the time spent and the tasks performed;
- to include a seminar in which uncooperative behaviours are acted out, in order to avoid them. This idea has led us to seek the collaboration of psychologists from our university, who has demonstrated interest in this course;
- to continue the seminar on 'The Causes of Failure in Project Groups', as it has been very well accepted;
- to continue the early assessment of the groups 'at risk'; and
- to include lectures on 'Social competences' and 'How to define goals' in the curriculum of Project Management.

CONCLUSIONS

The approach followed in this Project Management course at the University of Zaragoza has been based on: providing solutions to real customers' problems, fostering the functioning of work teams and creating a group of mentors that learns from the experiences of the course. We estimate this approach has been efficient, judging from the results obtained in our environment.

A new concept of an experiential learning laboratory of Project Management based on the study of newly formed project groups has emerged. From the learning point of view, results have been very positive. The course goals have evolved over the years to the main goal that is currently pursued: to ensure that none of the project groups ends in failure.

The analysis undertaken on 41 cases has shown that internal group coordination is an important aspect influencing the group work results, for several reasons: first, the group coordination was found to be the most frequent cause of project failure; second, the existence of a coordinator within the group positively affects the project group performance and, finally, the opinions gathered from the project groups have been unanimous in stating the importance of this factor on the final results.

Furthermore, the research has identified a trend in the students' perception of three different issues: the effort still needed, the end-success of the task and the expected customer satisfaction. In all cases, the students were overly confident about their possibilities, regardless of the actual results that they eventually obtained. They underestimate the time they will need to complete the project, they suppose their project will reach the set goal and they also trust that the customer will be very satisfied with the results.

Finally, we also hope to eventually confirm (by our experience from more courses in the future) that the group results are better if the group goes a step further and implements the project, instead of leaving it at the final presentation stage.

FUTURE COLLABORATIONS

We are very willing to help in the transfer of this model to groups interested in its implementation, be it universities or companies. Moreover, we are also willing to develop a collaborative framework of research to work on those aspects that may influence the success or failure of newly formed project teams working for real customers.

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