

Developing Teamwork Efficacy Factors: An Experience in a Project Based Learning Context*

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Teamwork is an important skill for the engineer. Numerous universities are designing and experimenting with training programs to develop this competency among their students. The aspects of teamwork that are practiced may vary depending on the methodology used and the context it is used in. But, what teamwork factors influence the effective working of a team? What strategies and activities can contribute to the development of efficacy factors among teams of students in a Project Based Learning context? Having undergone the experience, how important do the students think these efficacy factors are? An activity program was designed and implemented in a CAD subject to develop selected 14 teamwork factors. A pre-post test design was used to compare the level of compliance and to evaluate the importance that the students gave to each of them, using quantitative analysis. Questionnaires were also used with open-ended questions on the experience which were analyzed qualitatively. For all of the factors the level of compliance is higher than for previous experience. The students rated as very important all 14 factors included in the research. The students' perception of acquiring knowledge about efficacy in team working increased significantly. The students also rated positively the instruction they received. We conclude that the activity program and the strategies employed contributed to the smooth operation of the teams and helped to put into practice and develop factors that contribute to effective team working. The most important factors are those related to behaviour, interpersonal relationships and attitude.

Keywords: teamwork; efficacy factors; project based learning

1. Introduction

In 1996, the ABET Board of Directors adopted the new set of standards, called Engineering Criteria 2000 (EC2000). The new criteria specify 11 learning outcomes, among which was teamwork. In a later report [1], 95% of the 1622 employees interviewed rated teamwork as an important or essential skill for engineers, in 5th place in importance among the 11 a-k outcomes for new hires. This compels universities to design programs that develop this competency in students. Hence, engineering educators stress the need to develop team working skills [2, 3]; however, there are studies that show there is still a lack of these skills among students [4–6].

Among the learning methodologies that employ student group work as part of the teaching strategy is Project-Based Learning [7], Problem-Based Learning [8], and Cooperative Learning [9, 10]. These three methodologies are being introduced in many institutions, while in the context of engineering, Project-Based Learning is regarded by some authors as the most suitable for the simulation in a university environment of tasks that are as close as possible to those carried out by engineers in their professional practice. It seems that this is likely to be more readily adopted and adapted by university engineering programs than Problem Based Learning is [11].

The aspects of teamwork that are practiced may vary depending on the methodology used and the context it is used in. Some authors identify four types of team in organizations: work, parallel, project and management teams [12], and mention a range of factors that impact on the efficacy of these types of teams (interdependence, composition and group organization, communication, objectives, ground rules, etc.). On the other hand, the time factor has a direct bearing on the performance of a team: the greater the level of complexity and accuracy of the projects, the greater the development of the team's skills [13].

Hence, considering research contributions to this field, it is necessary to determine and decide which concrete aspects of team working we wish to develop with regard to the workplace context and the task that the students will have to carry out. In our case, the work presented in this article was implemented as part of the subject Computer-Aided Design, in which the students, working in teams, have to complete a design project.

Once the aspects of teamwork that are to be developed have been selected, teaching strategies and learning activities need to be designed that will enable the teams to work effectively. The students need support to work effectively in teams [14, 15]. Even so, according to Pineda, students frequently

do not take away positive attitudes to teamwork from these experiences, or do not see how teamwork is related to effective performance [16]. Bolton [17] found a discrepancy between teachers and students in terms of the satisfaction levels of classes based on teamwork: 91% of the teachers reported that they were satisfied, compared with just 64% of the students.

That is why, once our activity program is implemented, we have set as an objective to find out the students' opinion of the activity program they have undertaken, and to determine which of the aspects developed in it are regarded as most important to ensure effective teamwork in our context.

To summarize, this study sets out to answer the following questions:

- What strategies and activities can contribute to the development of efficacy factors among teams of students in a Project Based Learning context?
- Having undergone the experience, how important do the students think these efficacy factors are?

2. Performance factors in teamwork

There is a broad consensus on the need to develop teamwork skills among students. Nevertheless, research studies to determine which aspects influence the effective functioning of a team are not very numerous, and propose models that vary depending on the professional field in which the study was conducted.

Among the areas in which the efficacy of teams has been most widely studied are in industry, business and management. McNair [14] proposes the translation of self-managing work-teams (SMWT) industry practices to education, and, with reference to various researchers, mentions the following aspects of teamwork: to *operate collectively* and *autonomously*, *leadership* coming from within the team, *interdependence of tasks*, and *empowerment of workers*. Alper et al. [18] showed that certain types of *team goals* contribute directly to empowerment and efficacy outcomes, reporting that *cooperative goals* help self-managed teams gain confidence and work cooperatively. Tonso [19] stated that, even though the vast majority of researchers make clear that *social interactions* are at the heart of effective teamwork, face-to-face interactions are rarely studied in enough detail. Studying small-group decision-making, researchers from business management and communications studies focused on *behaviors* linked to effective teamwork, reducing negative behaviors by skillfully managing conflict, and taking advantage of positive behaviors [20]. Levi and Slem [21] highlighted management's

supporting teamwork (e.g. having *clear direction and goals*, good *leadership*, *tasks suitable* for teamwork, and necessary *resources*), attending to human resources aspects of *team composition* (e.g., qualified members, commitment, and organizational rewards), and *internal and external team relations*. Zafft et al. [2] study the impact of student's *leadership profiles* on team efficacy, and mention the *shared leadership* based on the various roles of team members, confirming the advisability of distributing leadership among all individuals within the team instead of being held by one individual.

The academic context differs from the professional, and here the question arises as to whether the aspects that impact on efficacy in teamwork in the field of engineering would have the same influence in the academic context and whether they are directly transferable. In this regard, Hirsch and McKenna [22] suggest that students value most of the same characteristics of a successful team identified by the literature about successful teams in industry. Nonetheless, although the teamwork literature says that commitment to a shared goal or common purpose is the most important characteristic of a high performing team [23], only 48 per cent of their students referred to this component, and of those, only half associated this characteristic with their definition of a "true team".

It is likely that the better professional working conditions are simulated in a university environment, for instance asking the students to carry out group projects which they would encounter in a professional context; the better these will coincide with the incidence of team efficacy factors in both contexts. In a series of questionnaires administered to 92 students in a Project Management course, Cano et al. [24] found a statistically significant relationship between the variable "quality of the performance as a project group" and efficacy factors that are also mentioned in the professional context such as *common goal*, *pleasant working environment*, *good communication among members*, *defined roles of each members*, *meetings*, *distribution of tasks*, *coordination within the group*, etc.

Hirsch y McKenna [22], analyzing the opinions of 112 students in Engineering Design, propose similar factors that contribute to successful team performance: *equal division of work*, *a shared goal*, *communication*, *trust/respect*, *diversity/members and different strengths*, *team standards*, *leadership*, *timely project management and organization*; *conflict resolution*; and *getting to know each other/having fun/feeling comfortable*.

Most of these factors recur in the studies of other researchers, although they vary from one to another in terms of how often they appear, the classification used by the different researchers, or the nuances that

they make depending on the context that the team is working in. Davis et al. [25] in a review in Engineering Education literature of the past ten years (up to 2008) identified the following teamwork attributes and behaviors derived from references: *roles and responsibilities/workload balance; member growth/leadership/initiative; performance expectations/accountability; peer/self-review, constructive criticism; behavioral norms, respect, support for others, climate; buy-in to full participation/interdependence, spirit; team processing/using differences, abilities; conflict resolution/team building; goal setting/goal driven/common focus; developing structures/plans/project mgmt.; decision making, consensus; potency/productivity; timeliness competency; process monitoring, review, celebration; meetings; communication, active listening, persuasion; shared understanding/learning.*

Taking these contributions into account, in the next section we will discuss the context of the subject in which the learning experience has been conducted and the factors selected to be worked on and developed by means of an activity program.

3. Activity program and strategies

3.1 Our context

The subject for which this teamwork development activity program was designed is Computer Aided Design, which accounts for 4.5 ECTS (45 class contact hours and 67.5 non-contact hours of study), for the degree in Mechanical Engineering in the Polytechnical College of Donostia, at the University of the Basque Country. The main objective of this subject is to ensure that the student has a theoretical and working knowledge of commercially available CAD software for the design of industrial components and machines. Furthermore, it is hoped that students will learn to work as part of a team to carry out a CAD Project (Fig. 1). Approximately 60% of the credits for this subject are devoted to the execution of the team project, while of the rest of the time, 20% is used to acquire knowledge of the basic software tools and the remaining 20% is devoted to in-depth study of the subject contents that cannot be covered via the project.



Fig. 1. Examples of CAD projects developed by teams of students.

Based on various open-ended scenarios, the groups of students (usually comprising 4 members) must define and agree on their own project which will fulfill the requirements of the scenario and allow them to acquire the competencies of the subject. Among the proposals presented are: the enhancement of an existing product, the design of a new and innovative product, the development of a virtual animation, the design of a construction-related toy, simulating an industrial machine, etc.

14 teamwork factors were selected to be worked on by the groups of students in this learning context. 8 of which are related to aspects of the internal functioning and relationships within the group, and 6 related to project organization and management factors (Table 1).

3.2 Activity program and strategies

For the design of the activity program the contributions of several researchers were taken into account [13, 19, 22, 26–29]. In Table 2 we show the activity program followed, with the objectives set for each activity, the factors worked on in each of them, the week in which it was carried out, and the strategies used by the teachers during the monitoring process. The subject was taught in 15 weekly sessions with duration of 3 hours per session, in a classroom with 30 computer work stations.

The first activity is intended to ascertain the entry level and to create mixed groups with diverse strengths. To do this, the students respond to a questionnaire about their prior knowledge needed for the project to be carried out successfully (knowledge of technical drawing, CAD software, and spatial awareness). They are also asked about their previous experience of team work, and in particular, about teamwork efficacy factors. Having analyzed the results, the teacher forms the groups (ensuring that they are mixed and comprise a diversity of strengths). Gender is also taken into account, to ensure that there are no single-gender groups.

In the next session, the groups are assembled and roles are assigned (coordinator, secretary), setting a common group objective for the project to be undertaken and for the subject, and establishing the ground rules. It is suggested that the position of

coordinator should be assigned according to the personal characteristics of the group members that are considered most suitable for this role. The role of secretary can be taken in turns. The groups will later assign other roles such as: part checker, drawings editor, drawings checker, graphic designer, etc, as the needs arise in the course of the project.

All decisions taken must be recorded in a group contract, signed by all members, which commits them to fulfilling what they have agreed upon. The teacher checks the contracts and ensures that teamwork factors such as communication, mutual respect decision-making by consensus and trust have been taken into account. For example, the students must establish what systems will be used for communication within and coordination of the group (Moodle forum, social networks, cloud storage etc.), and choose time frames for face-to-face meetings. If any gaps or aspects that could be improved on are noticed, the teacher can make suggestions. The objective is to organize the group so as to ensure that it works smoothly in the future, and that its members feel that they are committed to its success. Finally, in this session a series of alternative scenarios are presented as possible projects that the students can carry out so that the teams can brainstorm ideas and look for more information in preparation for the next session.

In the third session the goal is to define the project that the group is going to undertake. From the options that have been selected and based on the information gathered, the various alternatives are analyzed in terms of what each of them can contribute to achieving the learning objectives of the subject and one of them is then selected by consensus. The selection criteria are: workload, difficulty, usefulness, applicability of software tools, viability, originality and innovation. The proposals are presented to the teacher, who analyzes their coherence in terms of the objectives, viability, and then either approves the decision or makes further suggestions.

Once a project has been selected, it must be planned from scratch, with a breakdown of the steps to be followed in its execution, estimating how much time will be needed to complete each of

Table 1. Selected teamwork factors

Team internal functioning and relationship factors	Project organization and management factors
Diversity of members	Regular meetings
Assignment of roles	Project planning
Shared goal	Task assignment considering members' strengths
Team standards	Equitable allocation of work
Good communication	Task completion
Respect, trust	Project progress monitoring and assessment
Decision making, consensus	
Pleasant environment	

Table 2. Activity program and strategies for the development of teamwork factors

Objective	Activities	Factors	Session	Strategies and monitoring
Ascertain the entry point to create mixed groups with a diversity of strengths.	Students individually fill out <ul style="list-style-type: none"> questionnaires: prior knowledge (options to choose from and level acquired) previous experience of teamwork (Likert scales and open-ended questions) 	Diversity of members	1	The teacher forms the groups based on the results of the questionnaires.
Organize the teams' functioning and foster team spirit.	Meeting to: <ul style="list-style-type: none"> get to know each other (strengths), assign roles (coordinator/ secretary), set the group objective (to learn, to do a good project, to develop teamwork skills...) ground rules group contract 	Diversity of members Assignment of roles (coordinator) Shared goal (Team objective) Team Standards Good communication Respect and trust Decision making, consensus Pleasant environment	2	Through a process of setting up the group and signing up to a contract to commit to it (on a wiki) the teacher reviews the group contract, and may make some comments or suggestions if there are any gaps or weaknesses in the ground rules or the teamwork factors.
Analyze options and achieve consensus on the project to be undertaken.	Brainstorming, advantages and drawbacks of each option with regard to the learning objectives of the subject, and a selection of the project based on consensus in the team.	Shared goal (Project objective) Decision making, consensus	3	The groups present the proposal to the teacher. It is analyzed for coherence with the learning objectives, viability, options, until it is approved.
Project planning.	Carry out the planning stage with estimates of the time needed for the workload envisaged, sequencing of tasks, equitable distribution of work assigning responsibilities according to individual strengths, and review (reviewer role).	Project planning Equitable allocation of work Task assignment considering members' strengths Project progress monitoring and assessment Assignment of roles (reviewer) Decision making, consensus	4	Teacher reviews the planning and allocation of work/tasks.
Monitoring of the project and teamwork.	Report back on the result of the tasks assigned for that week to the group and to the teacher. Identify any problems with the functioning of the groups.	Regular meetings Task completion Project planning Project progress monitoring and assessment Other factors (if they arise): team standards, communication, respect/trust ...	weekly	Each week in class, the teacher meets with the groups, or monitors them via a wiki in which the teams post the minutes of their meetings and follow-up planning spreadsheets. Students receive feedback via the Wikis and face-to-face contact. Teacher records groups' progress in an observation logbook.
Analysis of the functioning of the group and any aspects that require improvement.	Group meeting and individual questionnaire: taking into account the ground rules laid down for the functioning of the group, analysis and evaluation by the team of how well they are performing and any aspects that require improvement.	Team Standards Good communication Respect and trust Decision making, consensus Pleasant environment Task completion Project planning Project progress monitoring and assessment	8	Follow-up meeting by the teacher with groups which had problems. Discuss the causes and proposed improvements.
Adjust the planning of the project.	Readjust the planning with three weeks to go for the completion deadline.	Task completion Project planning Project progress monitoring and assessment	12	Teacher and groups agree on the final tasks that need to be completed. In some cases a reduction in the group's objectives may be granted.
Evaluate the functioning of the group and the contributions of its members.	Evaluation of the functioning of the group in a meeting, and joint evaluation of the members' contributions by means of individual questionnaires. Questionnaire on the level of compliance of efficacy factors.	All factors	15	On submission of the project, the teacher meets with the group to evaluate its overall effectiveness and collective performance.

them, distributing the workload fairly, assigning roles according to individual strengths, with deadlines for completion and revision (assigning also the role of reviewer). In addition, an internal coordination procedure must be set up as well as a system of review of the work carried out, all team members sharing equal responsibility for the work they do as a team.

The first team meetings are conducted with an agenda set by the teacher. They are held in the classroom, with a time limit (30–45 minutes) and with the objective of establishing a habit of conducting meetings in a well-organized and efficient manner. From the fourth meeting on, responsibility is granted to the teams and they decide themselves when to meet and what agenda to follow. Minutes must be kept of each meeting and these must be available to the teacher and to the other groups by means of a Wiki. The minutes must record the issues discussed, agreements reached, allocation of responsibilities for tasks, milestones, deadlines, monitoring and review activity, corrections and modifications to the planning and an evaluation of the meeting.

On a weekly basis, the teacher brings the groups together in the classroom or follows up via the Wiki where the teams record the minutes of their meetings and post planning and review graphic displays, charts and tables. Students receive feedback in these classroom get-togethers or via the Wikis. The teacher records the groups' performance and development in an observation logbook.

At the half-way stage, in the eighth session, a special meeting is held to reflect on and analyze the functioning of the group over the previous seven weeks. By means of an individual questionnaire and bearing in mind the rules that were established at the outset, the students evaluate the functioning of the team and any aspects that could be improved upon. If problems are identified, the teacher convenes the group to discuss the causes and propose solutions. This activity is planned and is compulsory for all groups. However, in the weekly follow-up, any problem that has been identified with regard to the group's functioning is used as a means of reflection on what happened and to discuss teamwork factors. Generally, such incidents are rare and affect a minority of groups.

With three weeks to go before the project submission date, the students are asked to make a situation report as to how much of their initial plan they have been able to complete thus far, making a final readjustment of the remaining tasks if necessary. In some cases, it is acceptable to reduce the project objectives if there is not enough time left.

In the final session of the course, the project and overall performance of the team are evaluated.

Also, the individual contribution of each member is rated as well as the advice and guidance of the teacher.

Finally, the teams present their project in front of the rest of the class, with special emphasis on the skills applied, difficulties encountered and resolved, or new skills and knowledge acquired that were not taught in the classroom but rather were acquired in the process of carrying out the project. In addition, they are required to comment on how well the team performed. A final evaluation of the project that covers these aspects must be submitted together with the project outcomes.

4. Research design

The team work activity program has been run in classrooms for 4 academic years, from 2008–09 to 2011–12, with the participation of 137 students and two teachers.

We now discuss the data collection instruments used. A pre-post test design was used to compare and contrast a series of indicators, while open-ended questions were also used and the responses have been subjected to qualitative analysis. Student responses were classified into categories by the authors of this study separately and then the categories were analyzed jointly until a consensus was achieved. The categories relate to aspects or factors of teamwork that were mentioned by the students.

Questionnaire on students' prior experiences of teamwork: this is a means to ascertain the entry point of the class. The students must describe what experiences they have had in previous subjects; comment on aspects, techniques or strategies taught by teachers; evaluate their level of satisfaction (Likert 1–10); evaluate their level of knowledge of how a team can function effectively (Likert 1–10); and comment the factors they consider most important for effective team work (response to an open-ended question with no prior input from the teachers concerning teamwork factors). Having responded to this question, they evaluate the level of compliance in their previous experience of the 14 factors selected for the study (Likert 1–5).

Questionnaire on aspects of the group that could be improved: the students comment 2–3 aspects that the group performed well in, and 2–3 aspects that could be improved. This questionnaire was administered approximately half-way through the project.

Questionnaire on the experience of the activity program undertaken: In this questionnaire the same items on the entry questionnaire are repeated: their degree of satisfaction with the teamwork activity experience (in this case the CAD subject); rating their level of knowledge of how a team can

work effectively; and commenting on the factors they consider important for effective teamwork. They are also asked to evaluate the degree of compliance of the 14 factors by their team, and rate them according to the importance they attach to each of them in achieving effective team work. Finally, they were asked to rate the team's performance (Likert 1–10).

Final questionnaire to evaluate the teaching approach: an evaluation of the approach used in the activity program (Likert 1–10); and an evaluation of the monitoring carried out by the teacher (Likert 1–5)—similar items to those proposed by Heylen [30].

As well as the instruments and indicators for evaluating the experience, additional complementary tools were used that provided information during the processes of implantation and monitoring: a weekly check-up questionnaire to measure the students' dedication to the project and the subject activities, minutes of the group meetings, messages posted in the group forums, the teachers observation logbook where any incidents were recorded and the feedback given to the groups, as well as questionnaires used by the group members to evaluate each other.

5. Data analysis and results

5.1 Previous experience

We conclude from the result of the entry questionnaire on previous experience of teamwork that this competency had not been practiced in a planned manner at any time in their studies hitherto. The students reported two types of experience: on the one hand, they had all taken part in groups of 2–3 students to draft lab reports, presentations and

other reports on various subjects, in 3–4 subjects during their studies up to that point. On the other hand, a minority of the students mentioned just one experience of carrying out a quarterly project in fourth year. CAD is an elective subject, and it is possible to enroll on it without having studied in fourth year; which explains why just 30% of the students were familiar with a project learning context. In these experiences, the aspects of teamwork were not practiced by means of a specific activity program; the students completed the tasks they were assigned, but were not given any guidance as to how to work together effectively. Neither was there any monitoring or evaluation of the group's work. Most of the responses to the question about guidelines or strategies taught by the teachers for teamwork activities were similar to this: *"They never told us how to work in a team. They told us that the work was to be done in a group but we had to work out how to work together ourselves."*

5.2 Level of compliance and importance of the factors

In Fig. 1, we observe the variation obtained in the compliance of each of the 14 factors of our study, between the previous and the subsequent experiences, after completion of the project and the activity program.

The level of compliance after the experience of the activity program shows a variation of between 3.6 and 4 for the majority of the factors (Likert 1–5), with the highest rating of compliance for the last three factors. For all factors the level of compliance is greater than that obtained in their previous experience. In general, the increase is greater, the lower the level of compliance reported in their previous experience. We conclude that the activity

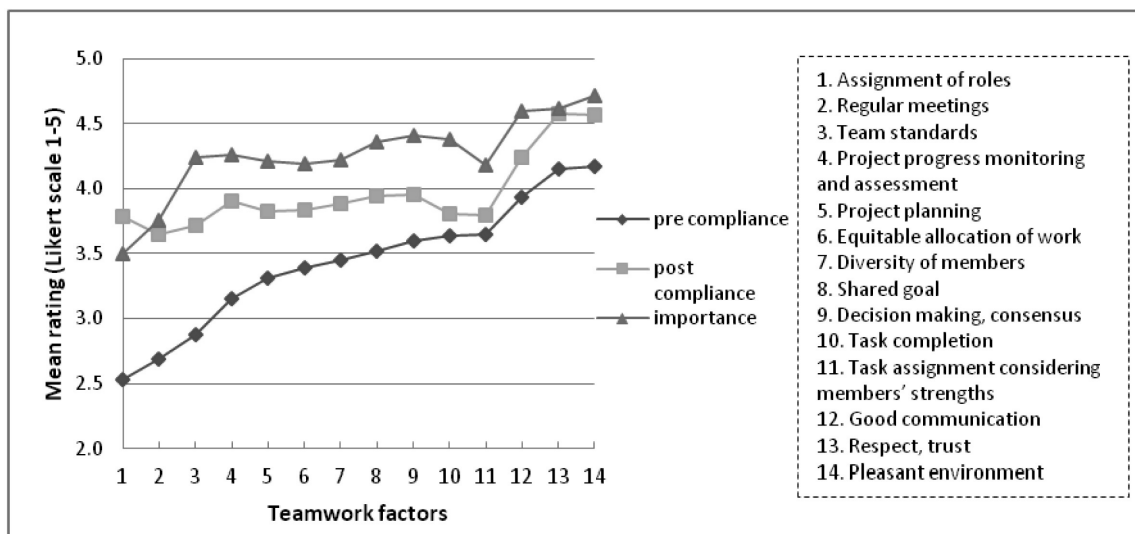


Fig. 2. Comparison pre-post of the level of compliance of the factors and their importance.

program and monitoring were successful in ensuring that the students implemented all of the factors that we had set as our objective.

Once the students had experienced all of the factors, we were interested to know what their opinion was. Are they important for the effective functioning of a team? What are the most important ones from their point of view? In the same graphic we include the results of the test in which the students were asked to evaluate the importance of teamwork factors along a Likert scale of 1 to 5. The reliability of the test was measured using Cronbach's alpha coefficient, and produced a value of 0.83. Internal consistency may be considered good, since the value of Cronbach's alpha coefficient exceeds 0.7 [31].

We can observe that the shape of the importance curve is very similar to that for compliance. The importance attributed to the factors is very high in all cases, above 4, except for the first two.

The factor *regular meetings* are one of the two factors with the lowest ratings, although it is still considered to be important (3.76). This result could be affected by the fact that most of the meetings were held during class time, and in an informal manner. The students remain in contact when they come to the centre, and this circumstance may mean that they do not see the need for periodic formal and organized meetings (with an agenda and minutes taken), unlike projects in which members of various departments participate who do not have regular contact. In contrast, some groups experienced difficulties with arranging meetings outside class hours.

The factor considered least important is *assignment of roles*, which was rated as 3.5, lower than the rating given to compliance (3.79). This rating could be influenced by the Basque cultural context, in which there is a tendency to work in a collaborative and egalitarian manner, with shared leadership and without setting up hierarchies or choosing leaders within the group (i.e. a coordinator). Although the minutes of the meetings reflect that the groups did select a coordinator and a secretary, most groups chose to rotate these roles on a weekly basis. It is also possible that the small number of members per group (3–4 students), meant that it was not perceived as necessary to have roles such as group coordinator, secretary or moderator. In larger groups, probably, the need for them would be greater.

The 4 factors considered by the students to be most important are related to questions of behavior and interpersonal relationships: *Decision making*, *consensus*, *Good communication*, *Respect and trust*, and *Pleasant environment*. The factors related to the organization and management of the project (such as *Project planning*, *Project progress monitoring* and

assessment, *Task completion*, etc.) are also considered important, but to a lesser extent than those mentioned above. As teachers and engineers who have had experience in developing projects in our professional practice, this is something that strikes us as significant. In our case we would rate more highly such questions of organization and management of the project than behavioral aspects and interpersonal relationships. We assume that this is due to the fact that an academic environment does not reproduce exactly the same working conditions as professional practice. The students are not subjected to the same pressures as they would be in the event of poor planning or missing deadlines. Neither does such failure to hit deadlines entail the same consequences as would apply in a professional context. Possibly, if the students were in a professional environment, their perceptions would be quite different.

5.3 Factors mentioned as important in open-ended questions

At the beginning and the end of the course, the students were asked to respond to an open-ended question: "Based on your experience, what factors do you regard as important to ensure that a team works effectively?" In general, in every response, the students mentioned just two or three factors. Based on their previous experience, at the beginning of the course, the aspects they mentioned as important for effective teamwork were few in number. In Fig. 2 we show the percentage of students that mentioned each one of the factors. The most often cited were *pleasant environment* (30.2%), *good communication* (24.6%), *equitable allocation of work* (16.7%), *project planning* (12.7%), and *trust and respect* (11.1%).

At the end of the course, we observe a significant change in the number of times various factors are mentioned. There is an increase in the mentioning of *Assignment of roles* (20.7%), and *Project planning* (31.0%). There is a considerable fall in the mentioning of *Equitable allocation of work* (3.4%), while the factor *Task assignment considering members' strengths* emerges strongly (20.7%). This would seem to suggest that students, once they have experienced the assignment of tasks based on the strengths of the team members, consider this factor to be more important than merely allocating the work equally. The factors *good communication*, *respect and trust*, and *pleasant environment*, are still the ones most frequently mentioned. In our study we selected 14 teamwork factors for consideration. However, when we classified the students' responses into categories, we found one that we had not considered, one that is the most frequently mentioned in responses to this open question (over 45% in pre and post): *commitment and involvement*.

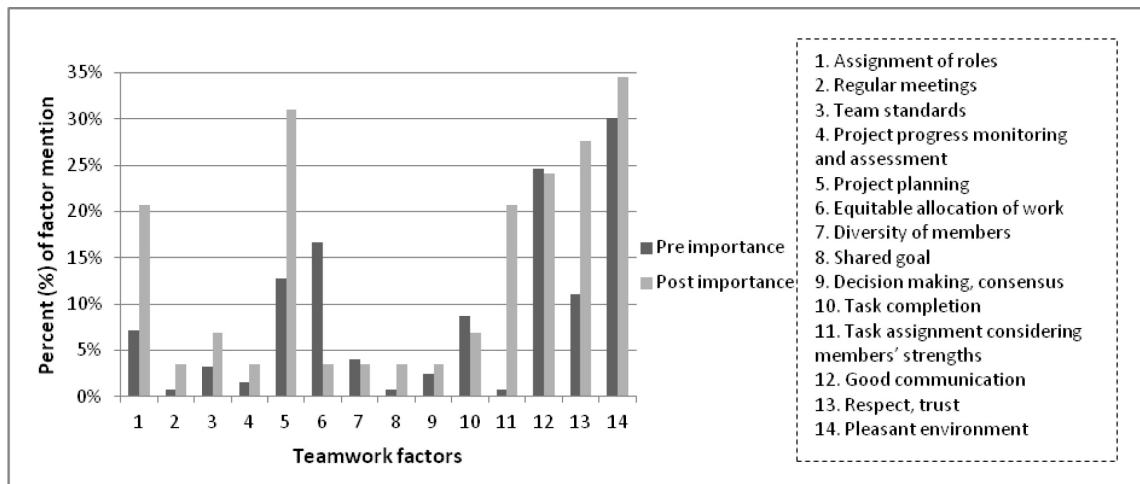


Fig. 3. Comparison pre-post of factors mentioned as important in response to open-ended question.

This factor refers to an attitudinal aspect of the group members, and reinforces the impression that, in this experience, students rate more highly factors related to behavior, interpersonal relationships and attitude, than factors related to organization and project management.

5.4 Aspects of the teams that could be improved on

To the question “mention 2 or 3 aspects that your group should improve on”, which was asked at the half-way stage of the project, the factors most often mentioned were *Project planning*, with 34.3%, and *Task completion*, with 24.8%. Although some planning was done, it was not carried out as had been envisaged. Since the students have no prior experience of this type of project, they could not easily estimate correctly the workload for the various tasks, and consequently, they were unable to make a realistic plan. For this reason, we stressed the importance of setting up a monitoring system and to make adjustments from time to time throughout the project.

5.5 Evaluation of the activity program and the instruction given

The effectiveness of the activity program can be seen in the variation of the indicators of the entry and exit questionnaires. The level of skills and knowledge for effective team functioning increased significantly. Furthermore, in academic environment or educa-

tional research, an effect size higher than 0.60 (Cohen’s *d*) is considered large [32].

The students also evaluate the instruction they received positively. The item “*the teacher gave us guidance on how to make the team operate effectively*” received a rating of 7.84 (dev 0.51). “*The course has helped me to learn how to work in a team effectively*” was rated 8.14 (dev. 0.71).

5.6 Relationship between teamwork factors and the functioning of the group

As for the functioning of the group, for the item “*rate from 1 to 10 the functioning of your group*”, the rating was 7.81 (dev. 0.41).

We analyzed the correlation between the importance given by the students to the 14 teamwork factors and the rating of the groups’ functioning (Pearson r_s). The correlation is positive for all factors, with a level of significance higher than 95% ($p < 0.05$), except for the factor “*diversity of members*” which produced a significance of $p = 0.058$ (94.2%).

6. Discussion

The activity program we propose is transferable as an introduction to teamwork for practically any subject that used projects as a learning context. The teamwork efficacy factors to be worked on depend on the academic qualification that the course is

Table 3. Acquired skills and knowledge for effective team working.

	PRE (N = 126)	POST (N = 137)	% variation	T student (p)	Cohen’s d
I have acquired skills and knowledge for effective team working	6.11 (SD = 1,71)	7.45 (SD = 1,29)	+21.9%	7.19 (p<0.001)	0.88

intended for, or on the professional profile that the course is designed to lead to. If it is intended to go into teamwork in greater depth, more specific aspects of the professional profile should be considered. For instance, for the context of software development project, the introduction of SCRUM (a versatile project management methodology), could be considered, with the specific roles and planning adapted accordingly.

From our point of view, it is not enough to ensure that the students complete the activity program. The important point is that, through the activities they engage in, they become aware of the factors that impact on the efficacy of the team. The results obtained from the evaluation that indicate they became more aware of these factors would indicate that this objective was achieved.

With a view to future implementations of this methodology, our intention is to expand the work roles. In addition to roles such as group coordinator and secretary, we think it would be useful to bring in roles more related to the professional profile of the participants (designer, plan editor, planner, etc.). We are also going to introduce the factor “*commitment and involvement*”, which we did not consider in this study and was mentioned by many students.

We would stress the point that planning is generally something that is rated quite differently in these activities from what actually happens later in reality, but it must be done. Perhaps the most important aspect of project management is the system of monitoring and assessment of planning, which, if necessary, may mean that adjustments have to be made to correct the initial planning.

We are struck by the fact that the four factors rated as most important by the students are related to issues of behavior and interpersonal relations, and not project management factors. It is possible that, if the groups comprised more members, or the project simulated a professional context more closely, their perceptions might be different.

Although the results are positive, their limitations must be taken into account: the results may be subject to variation depending on the context in which the activity is run, the type of project, the subject, the cultural environment, the strategies employed, etc. Another constraint to consider in the study is that the improvement noted by students is self-reported.

7. Conclusions

The students' evaluation showed a significant increase, both in terms of their satisfaction with the experience of teamwork, and of their perception of having acquired skills and knowledge as to how

teams can function effectively. The students also rated highly the teaching they received.

From our analysis of the results, we conclude that the activity program and the strategies used have contributed to the smooth functioning of the teams, and have contributed to practicing and developing factors that contribute to the efficacy of the team. The students rated the 14 factors of our study as highly important, although two of them were rated as somewhat less important than the others. Additionally we highlight that the most important factors are those related to behaviour, interpersonal relationships and attitude.

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