Active learning evaluation in the framework of Lab Project Management

M. Pérez-Moya*, M. Pérez-Fortes, E. Capón, A. Calvet, E. Boada and M. Graells
EUETIB, Departament d'Enginyeria Química, Universitat Politècnica de Catalunya, Barcelona, Spain

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Abstract

Current educational tendencies focus on combined development of personal skills and knowledge acquisition. The Chemical Engineering Department at UPC aims at increasing student abilities by introducing progressive learning methodologies to contribute to the present learning concept.

Final exams have usually been considered as evaluation tools for certifying knowledge acquisition. Present trends pursue greater evaluation criteria [1]. Learning Evaluation is serious enough to formalize a procedure to measure the impact and effectiveness of the learning process and ensure it is known and understood for everyone involved in. Thus, it is crucial to develop an evaluation strategy to measure to which extent all learning goals are being attained.

Experimentation in Chemical Engineering is a course at the EUETIB aimed at improving student abilities by running experimental projects rather than just performing a set of given measurements [2] and by understanding and using the lab not only as the room for carrying out these measurements, but as the theatre where playing and experiencing a series of professional roles [3]. This approach implies to favour the class environment for team work, communication inside and outside the group, coordination, time scheduling, as well as for personal skills development, such as leadership, negotiation and public communication abilities.

In this framework attention should not only focus on individual progress, but also on cooperative learning. Hence, efforts should be directed towards student self-evaluation and co-evaluation or partner evaluation [4]. The goal is to standardize an evaluation strategy that integrates the final product (Project Report) as well as the tracking of the individual roles and activities played by all the team members, including work planning, etc. Without such an assessment strategy, the aggregation of the diverse evaluation data may be unreliable.

Team Project should be evaluated not only as a final product, but also as a continuous work, taking into account task planning and the individual effort. To reach the aforementioned results it is necessary to establish evaluation guidelines to structure and manage team and individual labor to reach an integrated work evaluation framework. Also evaluation methods have to be adapted to favor student progress. Evaluation criteria are divided into three main points:

- Laboratory progress and aptitude monitoring.
- Critical reviewing, comparing and contrasting laboratory results (self-evaluation, co-evaluation).
- Final exam. Students are encouraged to prepare exam questions regarding their field of expertise, their own project.

On the other hand, implementation and analysis of these evaluation strategies should be easier enough to avoid meaningless results. Examples and templates are provided in order to make easier the implementation of the strategy and the interpretation of the results.

I. Introduction: Background of the Lab Project Management

The new paradigm for higher education has been caused by socio-economic changes, continuously emerging ITC tools, and consequently by the increasing need of highly qualified professionals. This fact has already been reflected in the European Space for Higher Education declaration.

As for laboratory classes, the traditional scheme has evolved to a more competence-oriented approach. Traditionally, the students were encouraged to reproduce the measurements in the lab. As a result, the mark agreed to the approximation to the theoretical values. Moreover, the knowledge was given in the theoretical classes and the lab was just its verification. In contrast, the new paradigm has as main purpose to design, run and manage a project for acquiring, building and communicating experimental knowledge. Therefore, the

[1] E-mail: montserrat.perez-moya@upc.edu

highest mark is obtained with the more the knowledge communicated. Above all, the knowledge is constructed in the lab, where the success conducts are acquired. [1]

The Lab Project Management (LPM) presented allows maintaining the same course programme of experiments-measurements simultaneously to the introduction of an experiment management at an upper level. Students are divided randomly in groups. Each team is in charge of an experiment and no experiment is bereft of a supervising group. Team Project consists of preparing open experiments with indefinite results, so that every lab team has to work independently its own experimental data. Hence, they develop their own conceptualisations of what they are studying. Students learn best through involving themselves actively in meaningful activities, in contrast to traditional passive methods, such as listening and repeating heard lessons, which do not require them to make conceptualisations.

The LPM concept perceives students as active learners, and recognizes them as producers of knowledge. Moreover, they discover that any behaviour has consequences, so the results of the Lab Project vary according to their attitude. Therefore, the evolution of students' behaviour changes along the whole period of the lab project. Students learn the importance of task planning, leadership, and coordination to achieve good results. Moreover, sharing experimental data forces students to improve their information management, their group internal organization and communication with the other team members and with the other teams. The objective is to transmit that experimenting is not just measuring, but also designing, planning, managing information, communicating results and providing economical evaluation of the experimental project.

This work describes an evaluation method in the framework of LPM of the subject Experimentation in Chemical Engineering (ECE) in Universitat Politècnica de Catalunya during the second semester of course 2007-08, which is based in three criteria:

- Laboratory progress and aptitude monitoring:

The first experiment assigned to each group corresponds to the project assignment. All teams run different experiments during each session, opposed to the idea of dedicating each session to a unique experiment. Students are expecting passing through the lab to get some measurements. And they are expected to manage an experimental project, which includes:

- Planning and monitoring: They have to define project targets, set up tasks, responsibilities and due-dates for team members, document the project phases and write minutes. As for monitoring, it allows introducing quality as a series of work habits. The previous tasks are asked to be done weekly and email it the faculty who may use this information to keep record of the progress made and to evaluate the non-presencial part of the course.
- Safety and environmental assessment: Students are responsible for supervising safety, health and environment aspects related to their project. Thus, they are asked to search for the necessary information, make their classmates observe the security measures and when incidents/accidents occur they are asked to follow the basics of a safety management scheme: act immediately, analyse causes, revise preventive measures and record the case.
- Economical evaluation: Students are asked for an economical evaluation of the whole project.
- Communication: It is crucial to know how to transmit the knowledge that they have generated orally and written. Hence, report and oral presentation are thus critical tasks. The LPM scheme increases the need of IT use. Communication is required through the email, reports, documents and templates that should be shared through the intranet. They also use IT to deal with a large amount of data.

- Critical reviewing, comparing and contrasting laboratory results (self-evaluation, co-evaluation).

Some sessions are dedicated to monitor meetings with a faculty supervisor instead of the lab work. A meeting at the office allows having a worthy feedback from the students.

During the course, students are asked for reviewing their classmates "traditional experimental report" using the same template used by the teachers to evaluate their project. At the same time, a supervisor also reviews the report. In these monitoring meetings, which take place parallely to lab or project monitoring sessions, students and supervisor criteria are compared and discussed.

[1] E-mail: montserrat.perez-moya@upc.edu

Self-evaluation and co-evaluation are done through surveys to evaluate students attitudes. This point is developed in the next section.

Finally, students are also required to fill in a nominative questionnaire, which is identical to the supervisors'one, asking for the oral presentation quality of their classmates (clarity of exposition, of tables and graphics presented, etc.). It is worth mentioning that filling in the same evaluation questionnaires for their classmates groups, which is also used to evaluate them by supervisors and by their classmates, drives students to consider the evaluation items when developing their project.

- Final exam. Students are encouraged to prepare exam questions regarding their field of expertise: their own project.

In addition to reports and oral presentation marks, students have to undergo a final exam, as an individualised assessment. This exam is jointly prepared by the students and the faculty. Each team is allowed to propose a series of multiple-choice questions related to their topic that the faculty will discuss, ask for changes and eventually approve. This type of exam preparation has shown to be more effective from the learning point of view, because discussing the questions provides a very interesting feedback to clarify doubts.

As a result of the new paradigm in the laboratory sessions, a different evaluation method should be applied: the perceptions and evaluations of students and teachers (subjective assessment) also have their own place in the final marks.

II. METHODOLOGY AND EVALUATION

This work describes the method used in the LPM for evaluating the competences of the students. They are asked to fill a survey to evaluate their own capacities (self-evaluation), and their group colleagues' ones (co-evaluation). Students are asked to fill the questionnaire regarding themselves as human resources managers. By doing so, the importance of competences in enterprise process selection and working career development are highlighted.

The evaluated competences can be broadly divided in four categories: team work abilities, communication, responsibility and attitude (Fig. 1 and Fig. 2). They are evaluated following a quantitative scale: from 1 (totally disagree) to 5 (totally agree). In addition, the last section survey is a global evaluation split in two parts: a global self-/co-evaluation, which is evaluated by means of a numeric scale from 0 (poor) to 10 (excellent), and a more descriptive part where students have to mention positive and negative points (they are obliged to write at least two) and general remarks where they can express their opinion about themselves/their group mates.

The methodology followed to fill the surveys consists of taking a member of each group to a quiet place, while the rest of the group is working in the last lab session. Hence, students are not influenced by their group mates. Some points have to be remarked: all the questions have to be filled, and the survey header has to be completed in the self-evaluation and co-evaluation, taking into account that co-evaluations are anonymous.

This self- and co-evaluation process is part of the subjective assessment of the final ECE subject mark.

[1] E-mail: montserrat.perez-moya@upc.edu

Name of the co-evaluated person:	
Group:	**Date:**

Imagine that you work as a Human Resources Manager and you have to make decisions to contract, promote or dismiss people: taking into account your experience in team work along your project in EEQ1, answer the following exercise about how you would be valued/how you value your co-workers' work. Cross the corresponding box.

AVALUATION INDICATORS

1	2	3	4	5
Totally disagree	**Disagree**	**I don't know**	**Agree**	**Totally agree**

You consider that your co-worker:

	TEAM WORK	**1**	**2**	**3**	**4**	**5**
1	He/she pays attention to ideas of other team members.	☐	☐	☐	☐	☐
2	He/she shares information with the rest of the team.	☐	☐	☐	☐	☐
3	In a discussion, he/she tries to reach agreements and does not impose his/her point of view.	☐	☐	☐	☐	☐
4	He/she contributes to work respecting the team agreements.	☐	☐	☐	☐	☐
5	He/she shows interest/participates in the work where he /she does not hold a direct responsibility.	☐	☐	☐	☐	☐
6	He/she relies on the work of other team members and respects it.	☐	☐	☐	☐	☐
7	He/she does his/her work with quality (respecting the established rules).	☐	☐	☐	☐	☐
	COMMUNICATION	**1**	**2**	**3**	**4**	**5**
8	He/she has good writing and oral communication capacity (clear and efficient).	☐	☐	☐	☐	☐
9	He/she uses the most suitable communication tool in each situation (email, personal meetings, etc.).	☐	☐	☐	☐	☐
10	He/she exposes his/her ideas with coherence, and it is easy to understand him/her.	☐	☐	☐	☐	☐
11	When he/she speaks, his/her participation is appropriate and concise.	☐	☐	☐	☐	☐
12	He/she uses an adequate vocabulary (technical, precise and professional).	☐	☐	☐	☐	☐
	RESPONSABILITY	**1**	**2**	**3**	**4**	**5**
13	He/she is punctual carrying out the tasks under his/her responsibility.	☐	☐	☐	☐	☐
14	He/she is punctual attending meetings and working sessions.	☐	☐	☐	☐	☐
15	He/she has capacity to make decisions.	☐	☐	☐	☐	☐
16	He/she acts with professional responsibility and social (safety, environment, etc.)	☐	☐	☐	☐	☐
17	He/she has shown leadership capacity in his/her tasks.	☐	☐	☐	☐	☐
18	He/she has been able to admit and correct his/her mistakes.	☐	☐	☐	☐	☐

Fig. 1. Survey for students co-evaluation and self-evaluation of compentences assessment (part 1).

[1] E-mail: montserrat.perez-moya@upc.edu

	ATTITUDE	1	2	3	4	5
19	He/she is receptive for learning new concepts, abilities and attitudes.	☐	☐	☐	☐	☐
20	He/she has been involved in the project, further than the simply fulfilling the tasks he was assigned	☐	☐	☐	☐	☐
21	He/she has shown capacity to relate the knowledge of this project to other learning's.	☐	☐	☐	☐	☐
22	His/her participation during the team working sessions has been essential.	☐	☐	☐	☐	☐
23	He/she acts with ethical and professional responsibility towards other people.	☐	☐	☐	☐	☐
24	He/she has/searches resources to solve the difficulties that appear.	☐	☐	☐	☐	☐
25	He/she has planned and managed efficiently his/her work load and time.	☐	☐	☐	☐	☐
26	He/she has capacity and criteria to find, manage and use the necessary information.	☐	☐	☐	☐	☐
27	He/she brings solutions, not problems.	☐	☐	☐	☐	☐

GLOBAL EVALUATION OF YOUR CO-WORKER

The classification extends from the minimum value of 0 (poor) to the maximum 10 (excellent).

1. His/her competences for group work, as well as his/her general attitude towards work, lead you to evaluate your co-worker as:

(0)	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

(Poor) (Acceptable) (Excellent)

POSITIVE POINTS Point out at least two positive aspects of his/her way to work:	NEGATIVE POINTS Point out at least two aspects that he/she should improve:
1. 2. 3.	1. 2. 3.

REMARKS

Fig. 2. Survey for students co-evaluation and self-evaluation of competences assessment (part 2).

[1] E-mail: montserrat.perez-moya@upc.edu

III. RESULTS

The results of applying the LPM survey for competences self- and co-evaluation for second semester of course 2007-08 in a group of 22 students are next presented. As general faculty feelings, it is observed a positive response from the students: despite the initial compulsory complaints (ECE is the only subject where students are asked to fill this kind of questionnaires), they are keen on the possibility to be allowed to express their opinions and feelings. Surprisingly, in most of the surveys, the optional field of remarks are completed.

Next, the figures of the statistical treatment of the survey answers are presented and commented.

Fig. 3 shows the mean and the standard deviation of each question for the self-evaluation of competences. Mean values are quite high (above 3), so most of students have a very positive concept of themselves:

- Group work: These competences are distributed along the whole range of scale (between the highest and lowest marked values) of Fig. 3. Nevertheless, the two most favorable items belong to this category: sharing information and respect. The works evaluated aspect is the interest in those parts of the project in which they are not directly involved.
- Communication: It is appreciated that students consider that they use the channels of communication appropriately. However, they do not feel so comfortable with oral and written communication skills: adequate register and capacity.
- Responsibility: The learners assign a high mark to the competences in this area. However, the leadership capacity is the less scored.
- Attitude: The most remarkable conclusion is that students consider that they are not efficient to manage their work load along time.

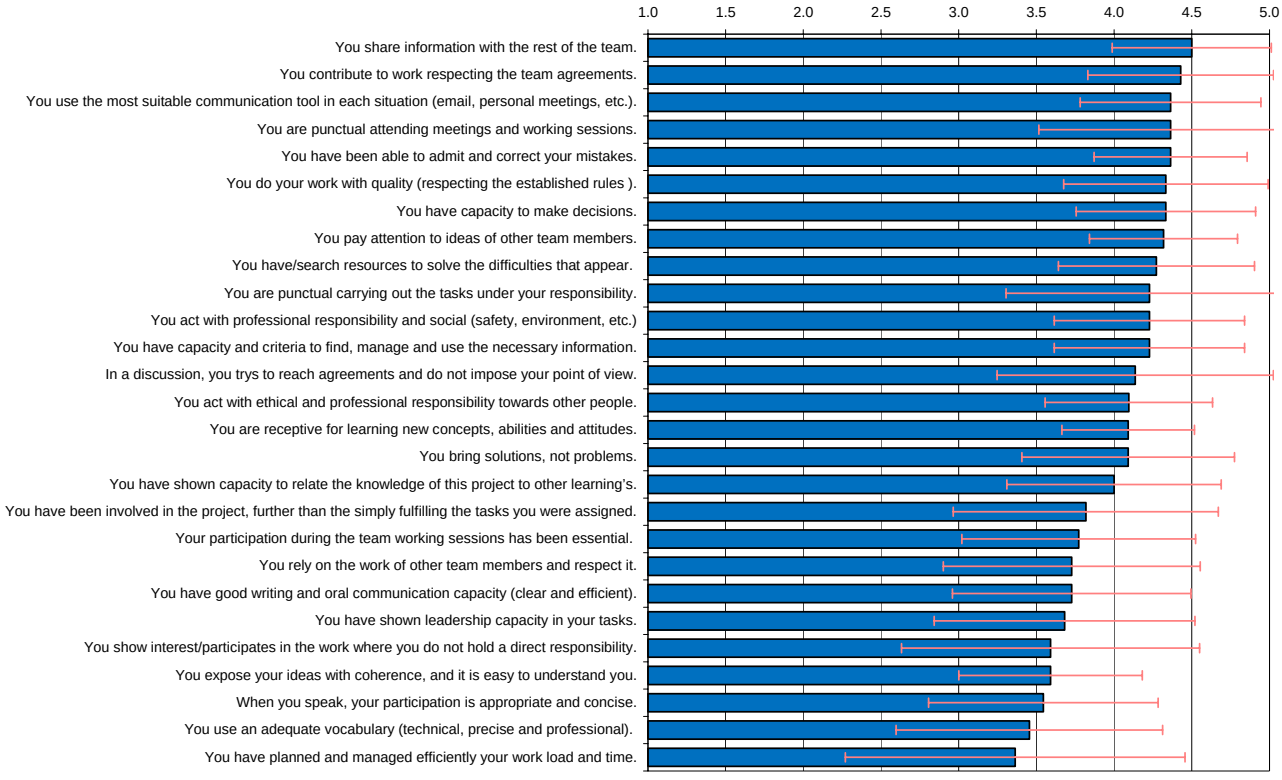


Fig. 3. Self-evaluation results of the survey, indicators from 0 (totally disagree) to 5 (totally agree).

Fig. 4 shows the mean and the standard deviation of each question for the co-evaluation of competences. Mean values are quite high (above 3), so most of students have a very positive concept of their colleagues. However, the standard deviation is higher than in the previous case, so there is a higher degree of disagreement. As general remark, the four groups of competences are homogeneously distributed along the whole range of scale (between the highest and lowest marked values). The most positive attitude value is the

[1] E-mail: montserrat.perez-moya@upc.edu

responsibility and professionalism of the partners; in contrast, the integration of different areas of knowledge in this field lacks in their colleagues.

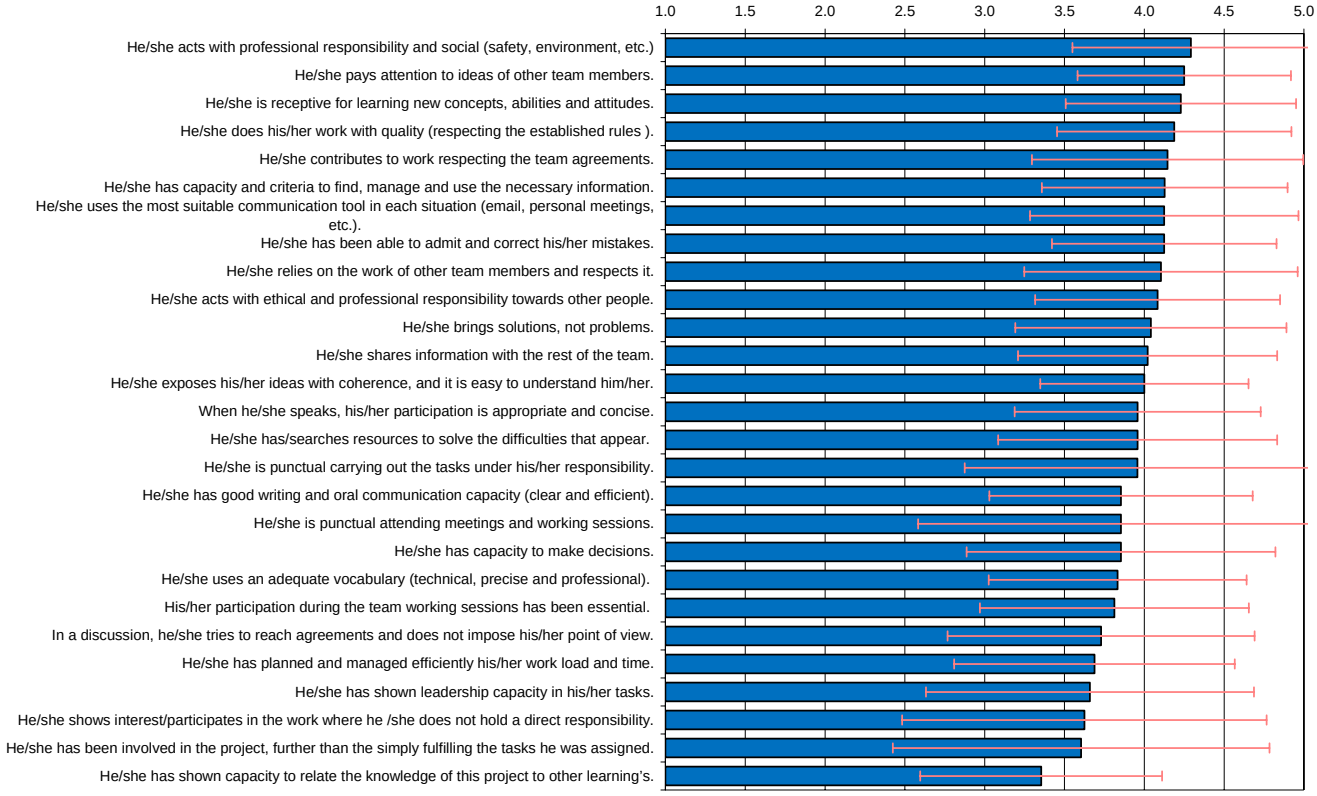


Fig. 4. Co-evaluation results of the survey, indicators from 0 (totally disagree) to 5 (totally agree).

Fig. 5 illustrates the mean difference between self- and co-evaluation of every survey question. Thus, it can be directly perceived the divergences between the criterion used to judge oneself and the others. In general, they consider that they can integrate other subjects knowledge in the project more than their team mates. In contrast, their colleagues' interventions are higher valorised.

Fig. 6 shows the global punctuation distributions of the self- and co-evaluation surveys. All of them pass their competence evaluation (punctuation mark of 5 or more). Although most remarks in co-evaluation are directed towards disapproval in both the behaviour of specific colleagues and groups in general, the global evaluation is always high. As Fig. 6 shows, self-competences are scored higher than group mates competences.

[1] E-mail: montserrat.perez-moya@upc.edu

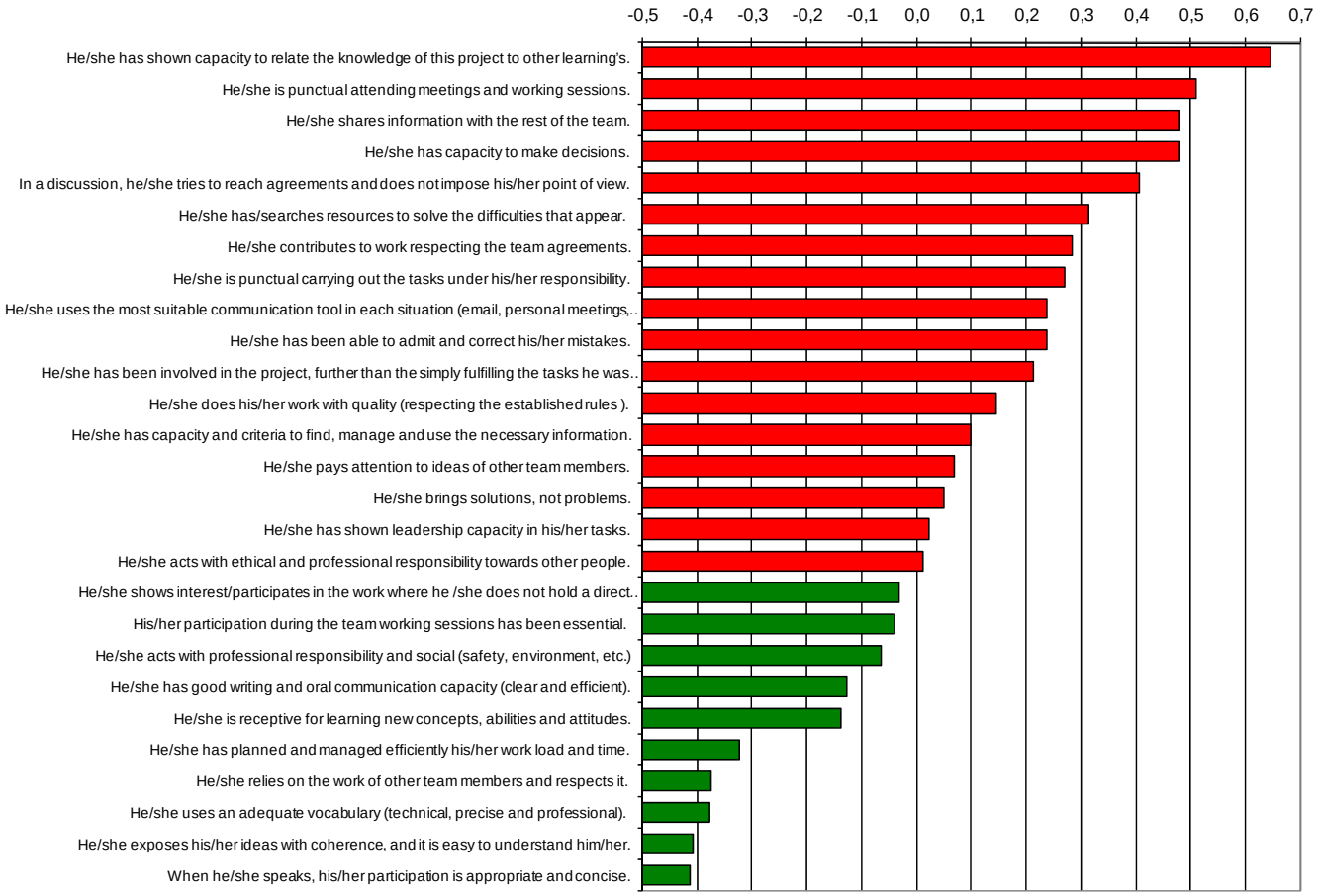
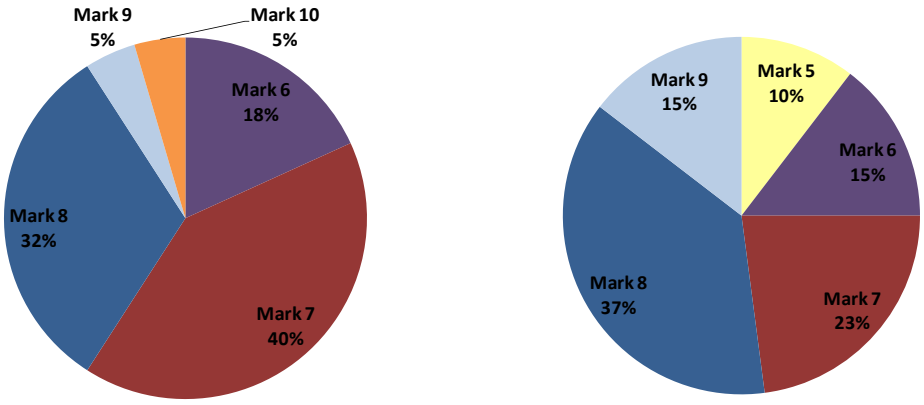


Fig. 5. Comparison between self- and co- evaluation results, difference of indicators (self-evaluation – co-evaluation).



(a) (b)

Fig. 6. Global evaluation for self- (a) and co-evaluation (b), indicators from 0 (poor) to 10 (excellent).

IV. CONCLUSIONS

Starting from a traditional situation, the described new methodology to evaluate cooperative learning and the management of a complete experimental project during the second semester of course 2007-08, has been considered positive for the students and the faculty.

[1] E-mail: montserrat.perez-moya@upc.edu

On the didactical side, the project based approach allows students developing capabilities such as planning, communicating, negotiating, solving conflicts, etc. as well as favour peer-teaching. On the pratical side, it is outstanding the acceptance and the active participation of students in answering the self- and co-evaluation questionnaires. Moreover, it is observed that students criteria to evaluate themselves and their colleagues' behaviour is similar.

The possibility of extending the model to other practical courses has always arisen and has been discussed. Certainly, it seems that the basis of the proposal is general enough to be implemented to any kind of experimental course since it is independent of the specific experiment being studied.

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References

[1] D. W. Johnson, R. Johnson and K. Smith, "Active Learning: Cooperation in the college classroom", (ISBN: 09-3960-314-4) Edina, MN. Interaction Book company, 1998.

[2] M. Graells, "Lab Project Management: A learning Scenario for Experimental Courses". International Conference on Engineering Education and Research "Progress Through Partnership" (iCEER-04). Olomouc, Czech Republic, June 2004.

[3] M. Graells, "Safety and risk Management: Learning of responsible attitudes at the lab". International Conference on Engineering Education and Research "Exploring Innovation in Education and Research" (iCEER-2005).(Tainan, Taiwan, 1 - 5 march 2005).

[4] K. Topping "Peer assessment between students in colleges and universities". *Review of Educational Research*, vol. 68, pp. 249-276, 1998.

[1] E-mail: montserrat.perez-moya@upc.edu