Evaluation of a Pilot Program that Integrated Generic and Specific Skills on Engineering Degree: A Case Study in Catalonia*

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The ETSEIAT (Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica of Terrassa) recently executed pilot programs to introduce generic and specific skills into its study plans. As these pilots are now concluding, an evaluation of their efficiency has been conducted. This paper analyses the answers given by professors who were interviewed (via in-person interviews and online tests) to determine how they developed and evaluated their students' skills. The results of these interviews offer clear data about the progress obtained by the pilot programs, how the professors understood the recently added dynamics and tools, and how the new skills are integrated into the various subjects and courses.

Keywords: engineering degree, generic skills, evaluation, oral and written communication, feedback

1. Introduction

At the Escola Tècnica Superior d'Enginyeries Industrial i Aeronàutica of Terrassa (ETSEIAT), several pilot plans have been conducted over the past few years to assist with the introduction of new skills into study plans [1]. To meet new requirements for university degrees in the European Union, much effort has been put forth to assess the various skills needed for all careers and degrees. A great deal of work has also been done to analyze how these skills can be introduced into courses. At the Universitat Politècnica de Catalunya (UPC) a Development of Generic Competences Plan (PDCG) was conducted for each degree [2]. This plan analyses a student's skill competence throughout his or her degree at three stages. For example, in the EI degree (bachelor's degree in Engineering in Industrial Technologies) from the ETSEIAT, the "oral and written efficient communication" skill was assigned to the first year "Informatics" course as a competence achievement level one, to the "Automatics" course as level two, and as level three for the "Projects" course. The UPC proposal, as in many other universities, consists of assigning a competence level in parallel to the course qualification. The way this has been done, both at the UPC and elsewhere, is to integrate the competence evaluation into the final qualification for the course. Even if all the course activities are qualified, there is always specific knowledge and generic skills to be developed.

In order to integrate the generic skills in all ETSEIAT degrees, the Grupo de Innovación docente de Terrassa (GID-T group, https://sites.google.com/site/gidterrassa/home) prepared training seminars for the seven skills approved by the UPC government council [2]: CG1—Innovation and entrepreneurship, CG2—Social compromise and sustainability, CG3—Third language (English), CG4—Oral and written efficient communication, CG5—Team work, CG6—Solvent use of information resources, CG7—Autonomous learning). An example of the seminar training materials [3] is provided to all professors at ETSEIAT. The main objectives of these seminars were to inform the professors of the new study plans and to assist them in creating new course plans which integrate the generic skills into the organized activities of each course. As shown below, the distinction between levels is often not clear or even apparent. Moreover, as determined through interviews with teachers, skills are assessed but not always deeply developed during the semester. As there is just a single test where all skills are evaluated, it is not possible to assess the students' improvements. If skill development throughout the degree is desired, the study plans should be designed with multiple assessment tests.

Additionally, universities should implement a system able to guarantee the quality and the correct acquisition of the training objectives. Such a system needs to satisfy the transparency requirements from the European Association for Quality Assurance in Higher Education (ENQA) [4]. At the Universitat Politècnica de Catalunya it was determined that the verification, surveying, modification and accreditation (Frame VSMA) [5], as well as the AUDIT [6] program established for the official degrees should be followed.

The university has the primary responsibility of

surveying its degrees. This is accomplished through the internal warranty system (SGIQ). It is therefore essential to have quality checks and continuous improvement in daily course activities [7–11]. The activities prepared for skills development at each level, as well as their evaluation (formative or summative) should be used to measure the skills' quality. The UPC Grup d'Avaluació de la Pràctica Acadèmica (GRAPA group) [7] created tools to help develop quality course activities. These tools strengthen the use of key methods during course activities, such as evaluation and feedback (among others) [12, 13]. During the evaluation students should be made aware of their weak and strong skills as well as their comprehension errors. The use of feedback introduces the opportunity to repeat an activity and to correct errors. This self-regulation is a skill that will allow students to continue learning throughout their lives [14].

This paper will analyze the strategy, activities and assessment instrumentation used [15, 16] for the "oral and written efficient communication" skill [17] that will be developed in three courses (one per level) throughout the degree. The quality measure has been tested and approved by the GRAPA group for these activities.

2. Methodology

First, the analysis of the data collection will be presented. This information has been obtained from ESTEIAT professors via two sources: an on-line internet questionnaire and personal interviews of EI degree (bachelor in Industrial Technologies Engineering) professors who developed and evaluated the "oral and written efficient communication skill".

Next, the strategy to implement the "oral and written efficient communication skill" in all three levels will be presented for three different courses, along with the evaluation tools [18] used for each course. This will help to identify similarities and differences that may exist in the development and evaluation of a single skill on its different acquisition levels. This comparison will also provide valuable information about what is being done and if the skill leveling has any sense for this specific competence.

3. Main results

The first data collection method, the on-line questionnaire, was used to determine how teachers evaluate generic skills. It was also useful to learn which strategies or activities they prepared and if they provided any feedback to the students.

3.1 Evaluation by on-line questionnaire

By an internal e-mail list, the questionnaire was sent to all the professors of the ETSEIAT using a Google doc platform [19]. It is an anonymous survey with ten questions that sought to determine:

(a) Whether the professor evaluates generic skills (either if they are integrated in the evaluation activities for specified skills or not).
(b) Which type of activities they had prepared in order to evaluate and develop the skills.
(c) What tools are used for the evaluations.
(d) Whether they provide a feedback.

From the 285 professors working in the ETSEIAT School, only 36 (a 13%) answered the survey. However, not all of them had generic skills in their program, so they were not able to give a proper answer. From the 44 courses that make up the EI degree, only 21 had generic skills to be evaluated [1]. The school also teaches other degrees, such as Aeronautics and some other Master degrees [20].

As shown in Fig. 1(a), 64% of teachers who participated in the study evaluate or develop generic skills in their courses (23 professors) and 21% of them develop the "oral and written efficient communication skill". From Fig. 1(b) it can be observed that the skills, that are among the proposed skills, the most developed or evaluated were "working in group" and "oral and written efficient communication" skills. The reason for the variety of answers is that some subjects had more than one generic skill assigned simultaneously.

Once we found out that there were 21% of teachers developing the "oral and written efficient communication Skill", we investigated how they evaluate and measure its proficiency in the different courses.

For a better understanding, the institution supplied training materials to professors (provided at http://www.upc.edu/ice/innovacio-docent/eines_i_recursos) to help them develop and evaluate activities, even providing functional guides. Simultaneously, at the ETSEIAT some training seminars were offered by the GID-T group [21] for each skill. To evaluate generic skills the training material recommended that a minimum of four tests (or equivalent) should be given. However, as shown in Fig. 2, a total of 74% of professors gave only one or two tests, which might be additive or formative. This confirms the existence of evaluation processes (probably not enough), but only in rare occasions a development of generic skills. Professors give tests to measure the acquisition of a certain skill, but fail to initiate any process to develop it. Occasionally, they provide advice to students to help them improve their skill.
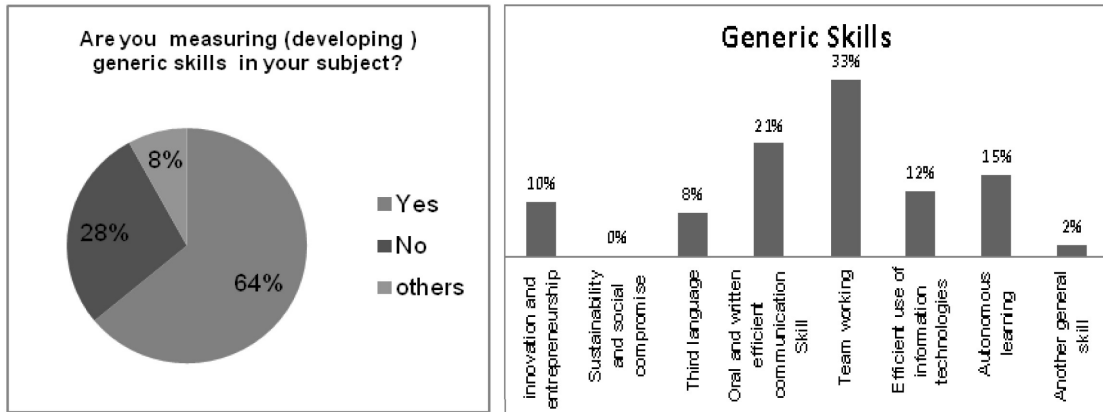
Fig. 1. (a) Percentage of teachers developing or measuring generic skills in their courses. (b) Distribution of the different skills that the teachers evaluate.
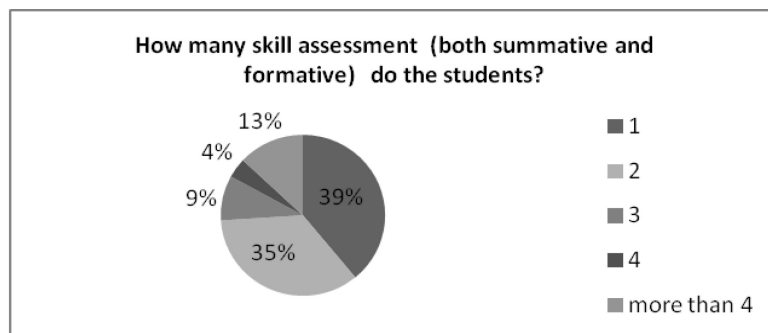

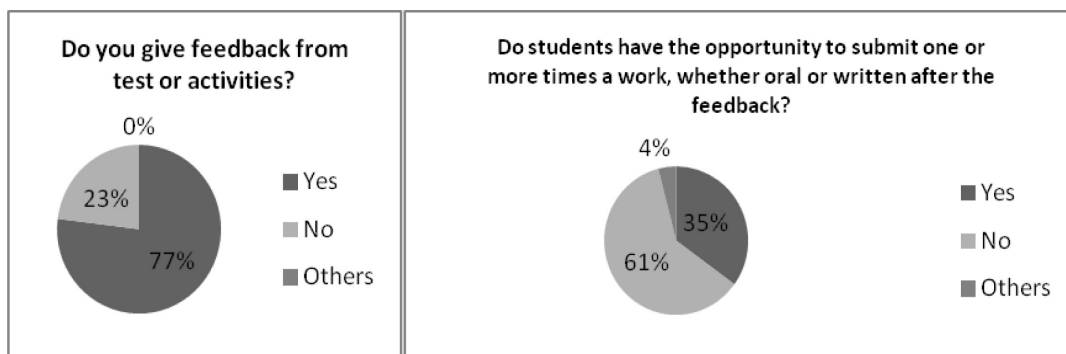**Fig. 2.** Evaluation tests done per subject to evaluate a generic skill.

Fig. 3. (a) Percentage of the professors giving any kind of feedback to the students. (b) Percentage offering a second opportunity to present the work done.

Additional evidence showing this lack of professorial follow up is demonstrated by the offered feedback. A total of 77% of answers indicate the existence of some kind of feedback of the students' works, practical sessions, presentations, etc. However, only 35% offer students an opportunity to revise their work based on professorial feedback, as shown in Figs. 3 (a and b).

The main evaluation activities for generic skills are: projects (22%), oral presentations (17%) and practical session reports (14%). In many occasions,

as evidenced in the answers given by professors, projects and presentations are completed at the end of the course therefore not allowing students to repeat those tasks or monitor their personal skill evolution.

Up to this point, and considering the available data, we conclude that the ''oral and written efficient communication skill'' is measured primarily by projects, presentations and practical sessions. Students are given feedback, but there are not many possibilities to repeat tasks. Globally,

there are at least three measures and activities for each skill, one per level acquired. However, evidence indicates that there is not much development during a course or from year to year.

3.2 Evaluation by personal interviews with professors

As mentioned above, personal interviews were done to professors who had introduced the "oral and written efficient communication skill" with the goal of checking the previous conclusions. In addition, it was useful to capture their perception on the skill level taught and measured on the students.

The interview consisted of five questions that established the bases for a deeper survey. The main questions are shown in Table 1.

To find the best candidates for the interviews, the list of professors who participated in the training seminar at the ETSEIAT in 2010 was used. At that time, a seminar was provided for each of the seven generic skills to be introduced in the degrees, as defined by the UPC [2]. In the "oral and written efficient communication skill" seminar there were eighteen teachers, although two of them are not affiliated with the university anymore. The interviews were recorded.

Noteworthy information was revealed during the interviews. Most of the professors did not remember the origin of the documentation and guides that they used to implement the activities in the courses and to decide the best strategies for their evaluation. They remembered having done, as a starting point, a course offered by the ICE (Institut de Ciències de l'Educació). In the following we show some of their answers:

"The maximal level is the 3rd" "my idea was to direct it to the 3rd level", "I think I used some tools from an ICE course for the 3rd level."

When reviewing the evaluation strategies that they used, we confirmed what was previously foreseen: they use projects, practical sessions and oral presentations at the end of the course.

"In the subject I believe . . . I do . . . the best" They do projects and, as the course advances, we do meetings and minutes of the meeting." "At the end, they do a presentation", "At the end they have an evaluation

Table 1. Guiding questions of the interview

You have X level for the "oral and written efficient communication Skill" in your subject. How do you manage its introduction?
Do you evaluate general and specific skills altogether?
Do you provide any feedback to the students?
In your course, after the first skill/activity evaluation, is it possible for the students to improve their qualification with a new presentation of the activity or work? Which is the percentage of students willing to have this second qualification?
In your course, and with the used methodology, do you believe that the evaluation level is the proper one? What makes you think so?

table for the written and oral presentation.", "We evaluate the content, if they get nervous, if they use tools and similar stuff . . . ".

"During the course the students do a business plan, with several parts in it. It is a part of the Project. At the end, they have to do an oral presentation. They have to sell me the product . . . it's not just a summary of the work done; they have to take all the work done and try to present it to someone else . . . This makes them feel strange, but they also learn that they can present something to different individuals and collectivities".

"The students develop a project: they do a report and a personal presentation."

"There is a previous presentation, where we give them some feedback. They get the grades on the evaluation table and they get some indications of their weakest points by e-mail. If the student is interested, he or she can come to ask for more details."

All courses, even those with more elaborated tools and methodologies, are evaluated by a single grade, and professors seem to feel more comfortable with this.

. . . "I do not evaluate the skills, but they are developed during the course. . . there are no grades specifically for it".

. . . "There is no defined system to evaluate with a numerical grade the performance of the skill".

. . . "I evaluate it combined with the grade of the course".

. . . "The final grade is formed by 8 sub-grades: meetings, tests, etc. but there is no set formula. I think I say it at the very beginning but I don't want them to go playing with percentages".

. . . "The evaluation of the generic skills has actually a binary value. If the subject is passed then it is considered as if the student has attained the required level. For planning reasons we've eliminated class presentations and they just have to give a presentation to the professor alone".

The feedback received also depends greatly on the subject and teacher. There are some with more methodological strategies and others who only provide a final evaluation, as demonstrated in the following comments:

. . . "for the Project course, provided that an important part is to know how to design a plan, there are some scheduled works that need to be completed, oral and written, and they receive the corrections to be done for the following assignments. We also use the co-evaluation or evaluation by equals methods".

. . . "We do not use methods to improve their skills . . . but I give them an evaluation of all the points . . . the points found in the evaluation table (or rubric) and general commentaries if needed. The students do an evaluation to their colleagues, with the same parameters that I use. Then they have all the reports there, so they can see what they did well".

. . . "We use an evaluation table for the different scheduled Works, and we try to guide them on what and how we want them to be done in the future. We also have an evaluation for the last oral presentation".

..."It's a first year subject . . . then, it should be level 1 . . . The oral presentation is evaluated by professors for the most technical and specific terms and students evaluate the credibility or the speaker's presentation of the product".

With the objective of investigating whether creating levels is a good strategy, it was found that possibly there is still work to do after hearing the answers from the interviewed professors.

. . . "Well, I designed it to evaluate the 3rd level but I don't know if I do it perfectly, I do believe so . . . I did a course once . . . For example, they do evaluation among students and that's a 3rd level, isn't it?"

. . ."I couldn't tell the level assigned in each subject I do . . . Though I think they do achieve the correct level"

. . . "Sincerely, I do not know exactly the differences between levels".

. . . "Creating levels is a good thing but it is hard to coordinate . . . For example, there's a teacher in the department that introduced the skill that I have to measure and evaluate afterwards, I gave him some tips and advice, but seeing the way he has it organized, I doubt he'll introduce them. I think it's hard, even more if there are other departments involved."

The interview also intended to observe whether they understood the difference between developing and measuring the skill. Some of them had it clearly in mind: "Professors without supervision realised what they believed was best but most of them just measure the skill, they do not usually develop it". Others did not know the exact meaning of the question; they related evaluation with grades and development with the performance of the skill if they passed the subject.

Therefore, by use of interviews among professors, it can be asserted that the skills are measured, but not developed during the course in most cases. What most professors do, usually in the first levels, is to check whether students posses or not the generic skill through an evaluation test. In the case of the oral and written efficient communication skill, it is evaluated by a final work or an oral presentation. In the last course, with a 3rd level of acquisition required, we found a good example of an exhaustive development of this skill in the project of the course, but in almost all other courses it is only confirmed whether or not the students posses the skill's abilities. This will be presented in the last part of the paper.

As major problems encountered, there are the lack of coordination and supervision of professors when introducing the generic skills in their courses and its developing strategies.

3.3 Comparison of three courses where the "oral and written efficient communication Skill" in all three levels is implemented.

In this part of the paper, we will summarize the evaluation activities of the "oral and written efficient communication skill" in three courses of the EI degree with different performance levels. The first course, with a level 1 implementation for this skill, is *Informatics*. It is a first year course and it has 6 credits. The second one is *Automatics*, a second year course with skill level two, which has 4.5 credits. The last one is *Projects*, a fourth year course with a third level of skill assigned, and it has 6 credits. In table 2 we show the definition and description of the activities for the "oral and written efficient communication skill" for each level and course.

Note that for the Informatics and Projects courses there is a project activity associated with them. Depending on the course and level of skill required, there are one or more assignments to do during the course. As shown in the Table 2, in the

Table 2. Skill level description and activities proposed per subject

	Level 1: Oral communication planning, answer correctly the questions that might be derived from it. Write texts with a basic correct level of grammar and orthography.	Level 2: Use strategies to prepare and develop oral presentations and written texts and documents with coherent contents, a good style and structure and a good grammar and orthographic level.	Level 3: Be able to communicate in a clear and efficient way in oral and written presentations addressed to a diverse audience, using adequate strategies and tools.
Skill level definition.			
	Informatics	**Automatics**	**Projects**
Written Works.	Project: A single written work will be presented.	A single summary work of the practical sessions will be written at the end of the course.	Projects: Three works should be presented throughout the course.
Oral presentations.	One single oral presentation at the end of the course.	In groups, the students do oral class presentations of the practical sessions. The idea is that with the information provided in the presentations, the other students will be able to perform the practical sessions correctly.	Oral presentation at the end of the year, but with some training in between.

first year the evaluation of the skills required is done by a final oral presentation. In the Automatics course, the skill is implemented in the practical sessions. Analysing with further details, the students give a single oral presentation that has been previously discussed with the professor and students in small groups; they also write a report of all the practical sessions completed.

Analyzing the feedback and evaluation provided by professors (see Table 3 for detailed descriptions); it can be observed that in Informatics there is a survey on the practical sessions which are related directly with the project. In addition, the students have the possibility to ask all the doubts they might have throughout the course and improve their work for the last presentation. In the case of Automatics, they have tutorial sessions with the professor, in order to check, ask and improve their job. In the last course, Projects, in addition to the advice provided by the professor during the weekly sessions, they have three scheduled work presentations. In all three cases students are provided with the evaluation table where the evaluation criteria are specified. After each test, a report containing the improvements to be made for the last presentation is completed.

As shown in Table 3, the skill acquisition evaluation is integrated in the final grade. The weight of the skills in the final evaluation increases with the difficulty and the level of the activity, from 20% to 60%.

The most used evaluation tools, as mentioned all along the paper, are the rubrics or evaluation table. In [8–10] there are many examples from the Projects course. In Table 4, the rubric for the informatics subject is presented.

Analyzing the examples presented to measure and evaluate the "oral and written efficient communication skill" it is interesting to separate them into two main categories: writing and oral expression.

Regarding the writing abilities, there is an evolution from the first level/year, with just one report assignment and a single evaluation at the end of the course, to the third level (last year), which has weekly meetings with the professor and three work assignments evaluated by professors and classmates. In this last level the development, the evaluation feedback and the improvement of the skill can be tracked throughout the course.

It is clear that in achieving writing proficiency there is a separation into levels in the efforts invested in developing the skill. As the student efforts increase by the degree advance it is supposed that the skill level acquisition should also be better as the years pass. But it is just an assumption as uncertainty is appreciable by the teachers' answers.

In the case of the oral expression skill, the same evaluation test is done at the end of each course. Hence, levels are not clearly defined and there is not a significant improvement or development of the oral expression skill throughout the degree. In this case there is no continuous improvement.

Seeing the lack of a clear level definition and working possibilities a deeper and more detailed analysis should be done for each of the different skills. Next we should reinforce the activities that contribute to the development of the skills. Currently they are being evaluated but not stimulated.

Even though many professors followed the training courses, the way to introduce the evaluation of the different skills and their development in each course depends on the professor's intention and

Table 3. Feedback and evaluation of the presented courses

	Informatics [22]	Automatics [23]	Projects [24]
Feedback	*The students have a week and a half to modify the final report after receiving observations and advice from the professor.*	There are special sessions with the professor organized in small groups to prepare the presentation of the practical session to the rest of students and to solve all the doubts they might have.	Each new scheduled work should incorporate the previous recommendations. In addition, professors offer possible revisions.
Evaluation	- documentation =15%, - program=75% - oral presentation =10%. The impact of this Project is of a 20% of the final grade. Additive evaluation	- Partial evaluation of the practical sessions: 15% - Final practical session evaluation: 15% Additive evaluation	60% of the final grade is the project : - 5% the first given work, - 5% the second given work - 30% the final written work - 15% final oral presentation - 5% Poster. *Formative and additive evaluation*
Evaluators	Written document: Professors Oral presentation: Professors and other students	Written document: Professors Oral presentation: Professors and other students	Written documents 1 and 2: Professors and students Final written document Professor Oral presentation: Professors and other students

Table 4. Evaluation table for Informatics

Criteria	Excellent	Quite well	Could be better	Needs improvement
1.Constant definitions	The values of the matrix dimensions, pi and gravity are defined as global constant, (Grade: 0.5)	Pi is not defined as a global constant (Grade: 0.25)	Gravity and pi are not defined as a global constant. (Grade: 0.05)	Constants not defined as global variables, They've been defined as locals, (Grade: 0)
2. definitions	The actions and functions are well defined. (Grade: 0.5)	Prototypes do not match with the required specification, but they are well defined. (Grade: 0.25)	The student changed the functions per actions, but they are correctly executed (Grade: 0.05)	The definitions are not correct (Grade: 0)
3.Principal programming	Local variables are well defined. Call for actions and functions are correct. Instructions for visualizing results are properly done. (Grade: 4.0)	Local variables are well defined.. Not optimal call for actions and functions because of an unnecessary use of variables Instructions for visualizing results are properly done. (Grade: 3.0)	Local variables are well defined. Incorrect calls for actions and functions Instructions for visualizing results are properly done. (Grade: 2.4)	Auxiliary functions not well defined. (Grade: 0.75)
4.Subprograms definitions	Functions headlines and actions are consistent with prototypes Correct local variable definition. Storage, instructions and assignations of values is correct. Correct data validation. Correct path algorithms. (Grade: 3)	Functions headlines and actions are consistent with prototypes. No optimal local variable definition. Correct storage, instruction and assignation of values is. Correct data validation. & algorithms (Grade: 2)	Function headlines and actions are correct but not consistent with prototype specification. No optimal local variable definition. Correct storage, instructions and assignations of values. Correct data validation. Incorrect path algorithms (Grade: 1.5)	Auxiliary functions not well defined. (Grade:: 0.75)
5.Execution of the program	Correct compilation. Screen visualized results are correct. All tests are solved. (Grade: 2)	Correct compilation. Screen visualized results are correct. All tests are solved. (Grade: 2)	Correct compilation. Screen visualized results are correct. Not all tests are solved. (Grade:1.5)	Program do no finish compilation and presented results are incorrect. (0)

perspective. Most of them do not have a clear understanding of the evaluation parameters and the definition of the proficiency level, making impossible the measurement of the skill level acquired by the students. At the present time, the generic skills evaluation is a binary value: If the student passes the course the skill is considered as "achieved".

A plan of improvement should be defined with precision to pass the study plans evaluations (AUDIT [6]). As an idea, it might be interesting to use the rating scale from other accreditation programs, taking the example of other universities [25]. This will help the Quality verification of programs with competences by levels. The guidelines from the European quality label for engineering degree programmes in Bachelor and Master level [26] (EURACE), which is one of the evaluation agencies represented in Spain by the Agencia Nacional de Evaluación de la Calidad y Acreditación [27] (ANECA) could be used to define the improvement plan. There are other agencies that can be consulted for the evaluation and control of the evolution of professional skills, such as the Accreditation Board for Engineering and Technology [28] (ABET). The

inclusion of all these possibilities will surely lead to a better plan.

4. Future issues and conclusions

We presented in this paper an evaluation of a pilot program that integrated generic and specific skills on engineering degree. In particular, we focused the attention on "oral and written efficient communication" skill.

First we have presented the results of a teacher's survey and we have seen that the main activities for generic skills evaluation are projects with 22%, oral presentations with 17% and practical session reports with 14%. In many occasions, as evidenced in the answers given by professors, projects and presentations are done at the end of the course, so the students receive some kind of feedback, but there are not many possibilities to improve by repeating tasks.

As we have seen, the separation into levels is appreciable when dealing with writing skills. This is an indication that, in spite of the difficulty in incorporating new methodologies, the system can work quite correctly. However, when dealing with

oral abilities, there is a lack of development and there is only a final evaluation that measures the skill level. Consequently, as mentioned above, a more exhaustive analysis should be taken for each of the competences to know whether the development objectives are reached or not in every degree and course.

From the interviews among professors, we can confirm that the skills are measured but not developed during the course in most cases. What most professors do, usually in the first levels, is to check whether students possess or not the generic skill through an evaluation test. In the case of the oral and written efficient communication skill, it is evaluated by a final work or an oral presentation. In the last course, with a 3rd level of acquisition required, we found a good example of an exhaustive development of this skill in the project of the course, but in almost all other courses it is only confirmed whether or not the students possess the skill's abilities.

What is clearly observable in this paper is the lack of coordination of professors, even within the same degree, in the evaluation and development of skills. To solve this situation, an important effort should be done to coordinate the work of professors so they can develop, evaluate and globally verify the levels per course.

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