

Integrating Generic Competences in an Engineering Degree Curriculum: the Students' Point of View

Carmen García-Berdonés
Universidad de Málaga
Campus de Teatinos
E-29071. Málaga (Spain)
+34-952137164
berdones@uma.es

Francisco David Trujillo-
Aguilera
Universidad de Málaga
Campus de Teatinos
E-29071. Málaga (Spain)
+34- 951952468
fdtrujillo@uma.es

Juan-Carlos Tójar-Hurtado
Universidad de Málaga
Campus de Teatinos
E-29071. Málaga (Spain)
+34- 952132543
jctojar@uma.es

ABSTRACT

Developing generic competences in bachelor degrees is not an easy task. In order to get a successful result, all actors in the teaching-learning process must agree in several topics, as the definition of each competence or the best approach for learning and evaluation. For this reason, the point of view of the students should be considered. This paper presents this point of view of students from several Engineering Degrees about how some generic competences should be trained and how this is currently addressed. Besides, self-perception of proficiency level in these generic competences has been assessed. We have used a survey methodology and the obtained results allow us to narrow down the focus on the role of the degree in training competences and the need of assess student skills before changing the curriculum. In a future work, these results will be contrasted with teachers' point of view in the framework of an overall research that is also briefly described.

CCS Concepts

• Social and professional topics~Computing education • Social and professional topics~Model curricula

Keywords

Higher education; Engineering degree; Generic competences; Oral and written communication skills; Second language skills; Teamwork skills

1. INTRODUCTION

1.1 Problems related to generic competences development

New adaptation demands towards the European Higher Education Area (EHEA) suggest two innovative parameters in the design of degrees: the European Credit Transfer System, (ECTS) and competences. The first one sets the learning effort of students as a new standard for measuring the degree workload. The second one shifts the learning process focus from the teacher showing content to students developing competences [1].

Competences are usually divided into two groups: specific (SC) and non-specific. The former ones depend on the specific degree while the later ones might be acquired by all university students, reaching different levels depending on their respective degrees. This paper will be focused on non-specific competences, hereinafter called Generic Competences (GC) although they can be found at literature as transversal, key or transferable competences, student attributes or just skills, depending on the context [2].

The transition from traditional learning to competence based learning is not being an easy process. In fact, more than a decade after the process began, there are still some unclear aspects. First of all, the term "competence" has not a unique meaning neither in its original area, Human Resources [3], nor in EHEA area, where different formulations of this term are shown in two significant EHEA papers: Tuning project [4] and European Qualifications Framework (EQF) [5]. In EQF framework, the different levels of qualification must be described in terms of knowledge, skills and competences. Here, competences are related to responsibility and autonomy. However, Tuning uses a higher level definition, stating that competences represent a dynamic combination of knowledge, understanding, skills, abilities and attitudes. Anyway, both approaches can be implemented as the so called Learning Outcomes (LO). LO describe what a learner is expected to know, understand and be able to do after the successful completion of a process of learning [1]. They should be defined in terms of measurable results. Hence, if your work is based on LO, you will be able to specify well defined evaluation criteria and chose suitable learning activities for students. However, Spanish curricular competences were initially stated following the Tuning approach. Although Spanish authorities have recently supported LO [6], in our opinion, the academic community is still in the process of adaptation to it. Therefore, we have decided to use here the Tuning high level meaning instead LO.

Competence based learning implies moving from a syllabus based on content towards a new one, coordinated and centred in the student who have to learn and learn to do [7]. This transition is not easy for any of both, generic and specific competences. However, it is particularly difficult for GC since the former syllabi included references to SC, by contents, but not to GC. So, for this kind of competences, there is not even an old model to be changed. It is important to choose an effective approach to ensure that students acquire GC, as well as to define the main parameters for this approach. A good starting point could be to choose one of the three general models for skill development proposed by [8]: embedded (within curriculum subjects); stand-alone (free-standing modules) or work placements. However, before taking that decision, the

expected resistance to some of them must be taken into account. For instance, [9] shows that some teachers are reluctant to adopt the embedded option.

Anyway, when designing a curriculum based on competences, the expected level of proficiency of students has to be defined and a progressive development, through the whole degree, has to be scheduled by using the proper learning methodologies and assessment tools. An additional issue must be previously considered in the particular case of GC: they are usually described in an inaccurate way. Teamwork is a good example. When you say “student must be able to work in groups” you are referring a set of skills (e.g. conflict resolution, leadership, oral communication) which can be non-well defined for all the stakeholders involved in the curriculum design (teachers, students, employers). European [10] and non-European [11-12] authors have addressed these issues. All of them agree with splitting large competences into more simple ones in order to improve the design. There is also a wide agreement in considering that all of them must be related to LO.

Several competence frameworks can be used to get a better definition of GC, or to split them into smaller parts if necessary. For instance, [13] presents UK standards for assessing key competences. Focused on assessment too, [14] proposes rubrics for Tuning competences. Related to Engineering area, we must cite the exhaustive decomposition of Engineering GC made in [11] or the accreditation frameworks for European [15] or US [16] bachelor degrees. Finally, a good source of information about GC is the large set of studies done to adequate the GC profile of graduates to employer needs, as, for instance, Tuning project [17] or Reflex project [18]. However, several authors show a critical view about using employer needs like the unique input to define education needs [19-20].

The development of the GC is even more difficult in bachelor degrees which include graduate professional responsibilities. Moreover, in this case, a discouraging definition of GC has been enacted by the Spanish Ministry of Education, without any taxonomy and using a fuzzy writing style.

1.2 Aims and stages of the framework research

The Telecommunication Engineering School (ETSIT) at the University of Malaga (UMA) teach five bachelor degrees with professional responsibilities. In our opinion, and due to the difficulties just described, SC have been widely treated in these degrees while GC have been relegated to the background; so it is important to review this issue.

A research is launched with the global objective of proposing some changes in current bachelor degree curriculum in order to improve how the development of GC is addressed. The proposal must be feasible, so, we need to know, not only which is the ideal way to develop GC, but also how is the current scenario (teachers, students, resources) in which the proposal will be applied. This information has been provided by two of the main groups of actors in the process: teachers and students.

Therefore, the following general objectives (GO) are drawn:

GO 1. Obtain information about the need of considering CG in the bachelor degree. More specifically, it would be necessary to confirm that it is important for graduates to attain GC and whether they should be developed at university.

GO 2. Obtain information about what and how we want to develop, that is to say,

2.1. Establish a clear definition of each competence, including its subcompetences, and the desired proficiency level we expect students to reach.

2.2. Choose an ideal model to develop skills and set its main parameters.

GO 3. Obtain data to figure out the current scenario, including context characteristics related with how GC are currently addressed. Here we will test our assumption: Up to now, there is no defined model to develop GC in the ETSIT bachelor degrees.

GO 4. Make a comparison between requirements imposed by the ideal model, and the current scenario, in order to study how feasible the proposal is and, if necessary, rewrite the ideal model or suggest some feasible changes of context.

We decided not to study all the GC included in the legislation, because they are too many and too diverse and because of the multiple parameters involved in their integration into bachelor degrees. Instead of that, we decided to focus this research on a limited number of GC: oral and written communication (OC and WC), English knowledge. (EN) and team work (TW). The main reason for choosing these ones is that they are addressed using very different approaches in the bachelor degrees. The first ones (OC and WC) are formally evaluated within the degrees; English (EN) is externalized and teamwork (TW) has neither been considered nor evaluated, but can be exercised in many scenarios in the degree.

Two phases has been defined in this research: teachers and students. In the teachers phase, it has been decided to use in-depth interviews in order to obtain information related with all our general objectives from ten selected teachers. In the student phase, information related with GO1 and, partially, with GO3 has been obtained by means of a survey methodology.

In this paper, the student phase is described. Next section covers its objectives and methodology. Main results will be presented in the third section and some conclusions will be exposed in last section.

2. METHODOLOGY

2.1 Questionnaire design

The performed questionnaire has been designed taking into account the general objectives, and it has been focused on gather information, for each of the chosen CG, about:

O1. The need to address GC in the bachelor degree (GO1 related)

Rationale Answers will give us cues about the attitude of students towards changing the current parameters related with GC development, For instance, an increase in academic activities designed for improving their skills, could be rejected because students think that they don't need them or because they think that this kind of learning should not be developed within the degree.

Operationalization. Need to improve GC, and if so, the depth of involvement of the bachelor degree. A five-point Likert scale was used.

Survey Question 1. If you do not need to improve [your oral communication skills/your written communication skills, your ability to work in a team/your English proficiency], tick option 0 and continue with the next question. If you do need to improve, do you think your selected bachelor degree should provide you the necessary training?

0 No need to improve; 1 No, the Bachelor Degree should train only on

technical issues; 5 Yes, the bachelor degree should provide me this training.

O2. The current level of involvement of the bachelor degree to get training in GC (GO3 related)

Rationale. We will contrast this information with the description of reality obtained in the teachers phase. In addition, we understand that the analysis of this information will provide us an important benefit. In our opinion, the perceived involvement could be identified by students as a message coming from teachers about the importance of GC. So, these messages, again, could be an explaining element of the attitude of students toward GC training.

Operationalization. Amount of subjects including activities devoted to improve GC. A five-point Likert scale was used.

Survey Question 2. Did the subjects you have studied include activities to improve [your ability to communicate orally/your ability to communicate in written/ your ability to work in a team/your English proficiency]?

1 No subject; 5 All subjects

Other two secondary objectives have been considered, So, we have tried to gather information, for each chosen CG, about:

O3. The perceived improvement in the skills since the beginning of the bachelor degree up to now.

Rationale. On the one hand, we aim students to tell us about their need to improve their proficiency level of the competence (O1). On the other hand, we ask them about activities, in the current subjects, related with GC improvement (O2). In order to compel the students to think about their answers, two intermediate variables have been included: perception of proficiency level before the beginning of the degree and perception of proficiency level at the time the questionnaire is administered. With these variables, it can be obtained the perception of improvement. Although these variables have the main objective of inviting the students to their reflection, they provide us interesting information concerning the perception of competence proficiency, so we have considered the importance of processing them.

Survey Question 3: At the beginning of the bachelor degree, you think that [you were able to communicate orally/you were able to communicate in writing/you were able to work in a team/your English proficiency level was] at a level

1 Basic – 10 Expert

Survey Question 4: Now, you think that [you are able to communicate orally/you are able to communicate in writing/you are able to work in a team/your English proficiency level is] at a level

1 Basic – 10 Expert

O4. Anything about the GC that the student wants to share with us. For this issue, a blank area was reserved for each CG.

2.2 Participants

In order to get the maximum number of participants, we asked for help to some teachers and the questionnaire was administered in classrooms, always at the beginning of a lesson.

310 volunteer students aged 10-35 years old (M=21.01 SD=2.64) participated in the survey coming from all the five bachelor degrees offered by ETSIT and studying in all the four years of each. Table 1 shows a more detailed distribution among degrees and years (SE: Electronic Systems Engineering; SI: Sound and Image

Engineering; ST: Telecommunication Systems Engineering; TM: Telematics Engineering; TT: Telecommunication Technologies Engineering). No compensation was provided for their participation.

Table 1. Detailed distribution of participants among degrees and years

Degree	Year				Total
	1 st	2 nd	3 rd	4 th	
SE Count	25	16	27	12	80
% within degree	31,3	20,0	33,8	15,0	100,0
% within year	31,3	17,4	31,4	23,1	25,8
SI Count	17	24	13	16	70
% within degree	24,3	34,3	18,6	22,9	100,0
% within year	21,3	26,1	15,1	30,8	22,6
ST Count	18	16	19	9	62
% within degree	29,0	25,8	30,6	14,5	100,0
% within year	22,5	17,4	22,1	17,3	20,0
TE Count	12	14	11	6	43
% within degree	27,9	32,6	25,6	14,0	100,0
% within year	15,0	15,2	12,8	11,5	13,9
TT Count	8	22	16	9	55
% within degree	14,5	40,0	29,1	16,4	100,0
% within year	10,0	23,9	18,6	17,3	17,7
Total Count	80	92	86	52	310
% within Degree	25,8	29,7	27,7	16,8	100,0
% within Course	100,0	100,0	100,0	100,0	100,0

3. RESULTS

Qualitative analysis of students' comments (nearly 44% of them filled in some of the designated areas) has provided very interesting information regarding the questionnaire goals. More specifically, we got information about activities currently being implemented, alternative suggested activities and the students' perception of teachers' involvement in the development of GC. However, this qualitative information will be presented here as a complement of those variables quantitatively assessed and, therefore, we will refer here only to comments related with them

3.1 Perception of improvement needs and the role of the degree

Figure 1 shows, for all the GC under study, a summary of answers to survey question 1. For each competence, three bars represent respectively the percentage of students who answered options 1 to 5 (They reported they need to improve the competence), the percentage of students who answered 2 to 5 (They reported they need to improve and they think the degree should help them) and the percentage of students who answered 3 to 5 (They reported they need to improve and they think the degree should be involved in helping them at more than a basic level). It is clear that a vast majority of students perceive they need to improve in all the four studies competences and they claim an relatively important involvement of the degree in helping them. This may suggest a positive attitude towards GC.

However, if we consider the development of all GC, not just one of them, the percentage of students supporting it significantly lowers down. Thus, only 71% of the students perceive they need to improve in all the four GC, only 57% think the degree should get involved at any level in helping them in improving all the GC and just 38% of

them judge that this involvement should be more than basic for all the GC.

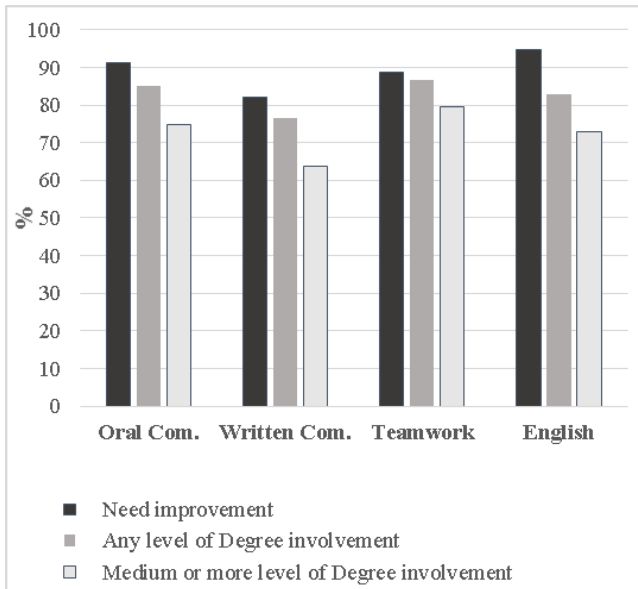


Figure 1. Percentages of students who need improve and think that Degree must be help them.

Let's consider that students prefer the degree to be involved in helping only with some GC and to devote the rest of resources in developing specific competences, instead of wasting them in not required GC. Then, we can think that there is not a clear agreement among students in which GC should be addressed. Figure 2 and Figure 3 show percentages of students who prefer develop several sets of CG.

Trying to dig into the causes of this scattering, we get from the qualitative analysis of students comments, obtaining results which could fit the following statements: "The degree should focus on technical issues", "Students should improve on GC by their own", "GC could be developed in high school" and "there is no time during the degree to work on CG".

Does this mean that some students think that engineering degrees shouldn't include training in GC for citizens, as it is widely assumed for other degrees? Which would be the basis of this idea?

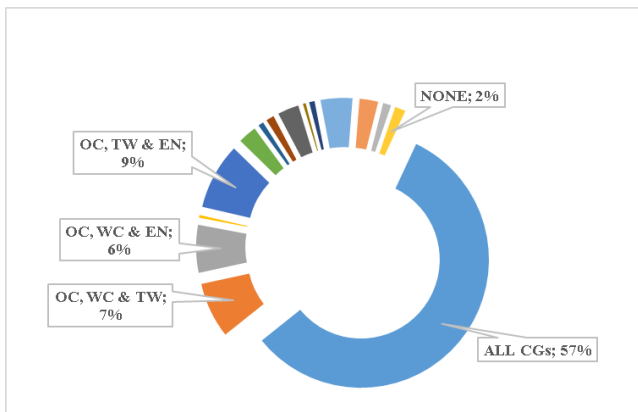


Figure 2. Percentages of students who prefer develop each possible combination of CG with any level of Degree involvement

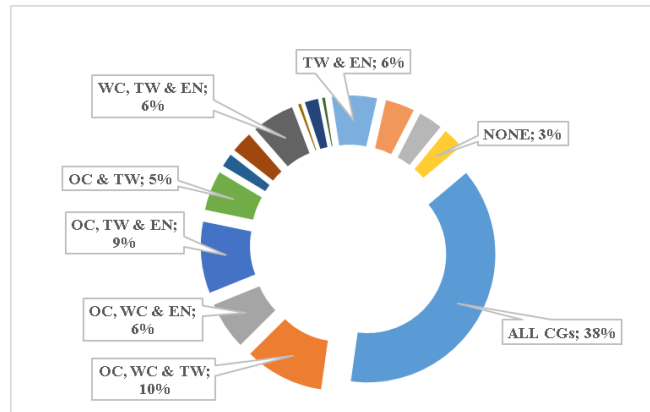


Figure 3. Percentages of students who prefer develop each possible combination of CG with medium level of Degree involvement

3.2 Skill self-perception

A Friedman test was run to determine whether there were differences or not among the GC under study in the student self-perception of pervious and current skills. Significant differences ($p < 0,05$) were found for previous skills ($\chi^2 = 81,607$) and for current skills ($\chi^2 = 150,169$). Perception of skill improvement was analysed in the same way and significant differences were found as well ($p < 0,05$, $\chi^2 = 131,609$). Then, pairwise comparisons were performed with a Wilcoxon signed-rank test (with Bonferroni correction for multiple comparisons). Results are shown in Table 2, where GC have been grouped where post-hoc analysis didn't reveal statistically significant differences between them. Median (Me) and mean (\bar{x}) are shown for each of the distributions.

Table 2. Comparison of CG for skills self-perception

		Me	\bar{x}
Previous Skills	WC	7	6,9
	TW	7	6,2
	EN	6	6,0
	OC	6	6,0
Current Skills	TW	8	7,4
	WC	8	7,4
	OC	7	7,0
	EN	6	6,1
Skills Improvement	TW	1	1,2
	OC	1	1,0
	WC	0	0,5
	EN	0	0,2

3.2.1 Perception of current skills

From previous table, we can see that students have in general the perception of having a high level of current skills in the four GC under study, specially for Team Work and Written Communication. Analysing in more detail these distribution, Figure 4 shows the whole histogram for Written Communication. A clear bell-shaped shifted to the high score is presented. Very similar shapes can be found in the case of Oral Communication and Team Work (not presented here). However, the case of English competence is

different (Figure 5). This histogram has a wider shape with some students reporting the lowest score.

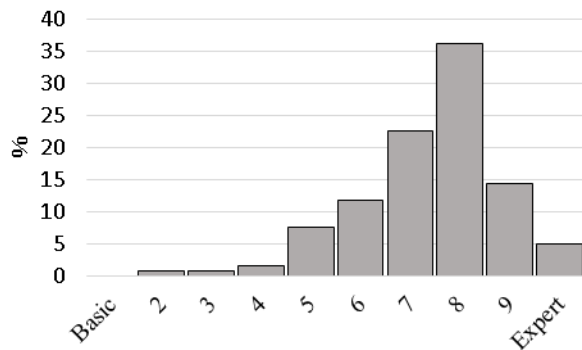


Figure 4. Histogram of Written Communication current skill

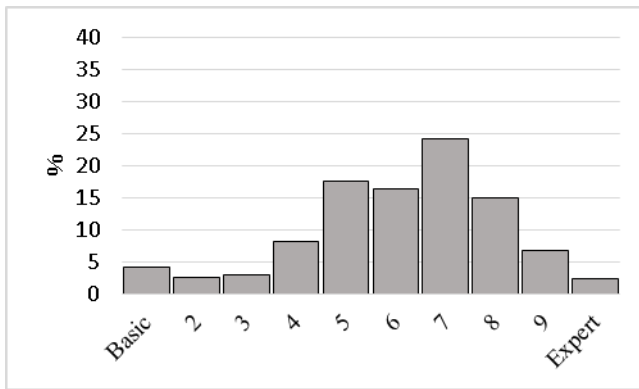


Figure 5. Histogram of English current skill

It is important to remark that no accurate definition of the GC was provided in the questionnaire. Therefore, the reported score just reflects the subjective feeling of proficiency. As students report relatively high scores in their current skill levels, we can think that even if they need to improve (as they reported as well), it would not be a big improvement what they expect. This could explain a negative attitude towards increasing the number of academic activities focused in the development of GC.

Looking at qualitative data, we don't find specific information about this issue. However, considering comments regarding evaluation, we might point out some interesting issues. There is no mention to the evaluation of the Teamwork competence. In this case, comments just refer to joint assessment of groups, but not to the assessment of individual behaviour of students within the group. Regarding Oral and Written Communication we can even find a complaint about the lack of feedback from teachers. Hence, *how could students report about their current proficiency in Communication and Team Work skills if they don't have any feedback from teachers about it?*

On the other hand, we can find comments pointing out that those subjects using documentation in English become more difficult to those students who are not proficient enough in this language. *Is English the only competence being actually assessed, as students have both external references (B1 qualification is required) and inputs coming from the difficulty of using documentation written in English, which is another feedback itself? Could this be the reason why English presents a higher dispersion in the reported current*

skills, which is in line with the scattering in reported proficiency extracted from the qualitative analysis?

It seems to be clear that students should have a justified reference about the proficiency level they are expected to have. That is to say, teachers must carry out a clear assessment in order to both, students and teachers, get an idea about actual students' skills. This way, we would avoid a wrong self-assessment, which could lead to a wrong valuation of the importance of improving the competence. It is possible that this proposed assessment procedure could bring to light a high dispersion in the actual student skills, which might be difficult to address. But, in order to tackle it, we think it is better to know that this dispersion exists, than ignore it.

3.2.2 Perceived improvement.

From Table 2, we can see that students have the perception of having a very poor improvement of their skills in the four GC under study, especially in English. The whole histogram for this GC (Figure 6) shows that about 20% of students report they are losing, instead of improving, their skills. For Written Communication, this percentage is around 10%. On the other hand, almost no losses have been reported for Teamwork (Figure 7) and Oral Communication.

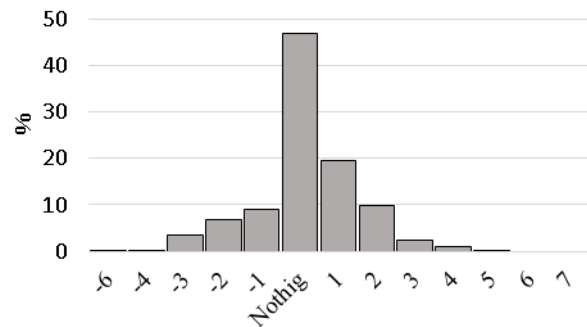


Figure 6. Histogram of English perceived improvement

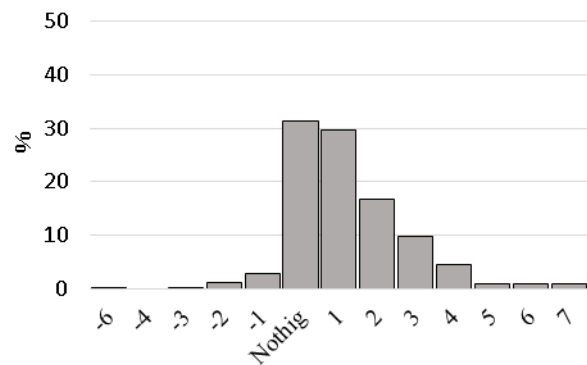


Figure 7. Histogram of Teamwork perceived improvement

3.3 Current involvement of the degree: subjects with identified activities

A Friedman test was run to determine if there were differences in the amount of subjects engaged with developing each GC, as reported by students. Significant differences were found ($p < 0,01$, $\chi^2 = 427,01$), so pairwise comparisons were performed with a Wilcoxon signed-rank test (with Bonferroni correction for multiple

comparisons). Results are shown in Table 3, where GC has been grouped using the same method as in Table 2.

Table 3. Comparison of CG for Subjects with GC activities

		Me	\bar{x}
Subjects with GC activities	TW	3	3,3
	WC	2	2,4
	OC	2	2,2
	EN	1	1,4

It is important to highlight that very few subjects are reported to have activities devoted to GC development. This is especially important in the case of English.

Students' comments are very clear regarding this. They openly describe teachers as not interested in training communication and English competences or, in any case, much more interested in training purely technical skills. They reported teaching methodologies not suitable for practicing these competences. Teamwork competence, though, is addressed by some activities as they claim that more attention from teachers is needed when carrying out these activities. Nevertheless, they also report that teaching methodologies encourage individual work and competitiveness.

We have already pointed out that it is interesting to know deep is the involvement with GC that students perceive in the degree, because we assume that perceive a low involvement is equivalent to receive a negative message and might make students reluctant to our goals. Analysing students' comments, we have found this negative message and possible consequences of it even more explicitly than expected. We therefore wonder whether students' reluctance to the involvement of the degree in training GC at the expense of technical contents could be, at least partially, just a reflect of that message sent by teachers.

4. CONCLUSIONS

In this study, we have made a first approach to students trying to figure out some of the sources of reluctance to training GC in the degree. In this sense, it has been pointed out here that we should keep looking into students' skill assessment, as well as the origin of their different opinions about the role that the degree should play in the development of each of the GC.

With this first contact, we also intended to know how students see the current involvement of the degree in the development of GC. Quantitative and Qualitative data have revealed a low activity of the degree in this field. We propose to keep investigating the possible relationship between this low activity and the position of students against the involvement of the degree in training GC, as it was pointed out before.

In order to close all the questions that this research has brought up, a wider research should be conducted having again the students as informants, but using a qualitative approach. However, before doing so, results presented here should be complemented with teachers' opinions extracted from the qualitative phase of the framework research where this work is included.

5. ACKNOWLEDGMENTS

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