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Achieving Competence-Based Curriculum In Engineering Education In Spain

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Abstract

The fact of placing competences and outcomes learning at the heart of the academic activity means overhauling the curricular architecture of higher education in Europe. Some universities have undergone important transformations moving toward a competence-based learning environment, while others maintain traditional curriculum packaged formats. In the realm of the European Higher Education Area, this paper examines the use of competence-based initiatives in curricular development for engineering degrees with special focus to the Spanish case. Although the concept of competence and competence-based learning have a long history in education and training research, these terms are still very diffuse and demand a clear conceptualization. In the first part of this paper, we provide a conceptual overview and a critical reflection of competences as implemented in a wide range of settings, including its origins, key concepts and definitions. Next, we discuss the purposes, principles, pitfalls, and processes that enable to define a map of competences within Engineering Education. Finally, we present a pilot project involving curriculum development and faculty enhancement within a competence-based learning initiative in Electronic Engineering.

Index Terms— Learning, competences, European Higher Education Area (EHEA), curricular development, Engineering Education

1 Introduction

Nowadays the whole engineering community is immersed in a vigorous debate trying to fix the competences needed for current and future engineering practice [1]-[2]-[3]. Some trends have the potential to change the practice of engineering and engineering education significantly: the general technological advances and pervasive use of information technology; the modification of value-added chains; the vast array of new materials and processes that broaden engineers design space; the increasing number and complexity of economical, political and ethical constraints (e.g., cost, safety, sustainability); the need for teamwork and the fast pace change calling for life long learning [2]-[3].

In the movement to the European Higher Education Area (EHEA) competences and learning outcomes are playing a central role and are considered a to be a keystone when dealing with two problems that the current engineering education system has to face: the fast technological change in the production and management of knowledge and the gap between education and job market requirements [4]-[5]-[6]. On the other hand, some studies show different patterns between acquired and required competences in the Mediterranean countries compared with the rest of European countries [5]-[7].

Formation based on competences is viewed like one of the pillars to advance in the EHEA process despite the fact that many important issues about its conceptualization and applicability remain unclear [8]-[9]-[10]. In this paper we provide a critical reflection of the competence-based initiatives in Engineering Education. In Sections 2 and 3 we present an overview of the importance, the historical background and the meaning of competences. In Section 4 we focus in the Spanish particular situation but our methods and conclusions may be extrapolated to other countries and in Section 5 we explain the experience in competence mapping in Electronic Engineering at the School of Design Engineering in the Polytechnic University of Valencia.

2 An overview on competences

2.1 Importance

Why this renewed interest and relevance in implementing competence-based initiatives in colleges and universities? Well, this question may receive different answers

depending on the perspective from which it is perceived, Firstly, the competence-based terminology might be considered more adequate for consultation and dialogue with many stakeholders as employers, graduated and other social agents. It can contribute both to the necessary reflection for the development of new degrees and to update the existing ones, thus reducing the effects of the mismatch between acquired and required level of competences in the labour market [5]-[7]-[11].

Secondly, competences empower tendencies such as vocational education and training (VET) and long life learning (LLL). In today's society, individuals are required to be flexible in terms of being proactive and adaptable (LLL) as well as in terms of mobility (employability) [8]-[13].

Thirdly, competences are a nuclear concept in the new teaching/learning paradigm, where approaches centred on the learner are increasingly important. It summarizes academic and professional profiles, defines new objectives in the learning process, enhances learning environments and shifts the concept of learning as accumulation of knowledge to learning as a permanent attitude towards knowledge acquisition. In fact competence-based education is considered the leading paradigm for innovation since it emphasizes the integrated nature of what students need to learn to face not only labour market but also life in general [13]-[14].

From the curricular perspective, specific articulations of competences inform and guide the basis of subsequent assessments. In this way, competences provide directions to design learning experiences and assignments that help students gaining practice in their use and application in different contexts [15]-[16]. This emphasis from input-output in the learning process is reflected in the assessment of student performance, moving from knowledge as the dominant (when not the single) reference to include a variety of approaches to assessment (portfolio, tutorial work, course work; peer, co and self-

assessment, etc.). Current competence based education gathers features of several other educative innovations, such as self-regulated learning, project based learning (PBL), coach learning, etc.

Competences and learning outcomes allow flexibility and autonomy in the construction of curricula and at the same time they are the basis to formulate commonly understood level indicators. From this perspective and within the process of building up an EHEA, competence-based learning contributes to the introduction of European Credit Transfer System (ECTS), facilitating the comparability and compatibility of educative systems [11]. At the 2003 Berlin meeting, the Bologna Working Group on Qualifications Frameworks (2004) encouraged Member States "to elaborate a framework of comparable and compatible qualifications for their higher education systems, which should seek to describe qualifications in terms of workload, level, learning outcomes, competences and profile". At present there are four strata of qualification frameworks in different stages of development in the EHEA. The most general that has been agreed to and promulgated is the transnational Framework for Qualifications (FQ) of the EHEA, gathering the "Dublin Descriptors" and setting out definitions and levels of competences for a Bachelor's degree, a Master's degree, and a doctoral degree [12].

2.2 Historical background

There is a variety of perspectives about the origin of competences, with backgrounds in diverse areas such as linguistics, cognitive psychology, business organization, management development and education [14]-[17]-[18], thus being able to find that the terms competence and competency are used in various ways in the literature [10]-[19].

And although these concepts are commonly used in the educative area in some European countries (United Kingdom, Denmark, Finland, France, among others) there is an increasing criticism about the ambiguity of its use and the lack of a theoretical frame supporting it [8]-[18]-[26]. In this way Weinert affirms that there is no basis for a theoretically grounded definition or classification from the seemingly endless inventory

of the ways in which the term competency is used which range from the scientific discussion to the political discourse [18].

A very first question issue that arises: Should we use the term competence or competency? In a 1995 article entitled "Demystifying Competence" Michael Armstrong asked "…what does competence mean? It is all very confusing. Every definition is different. We hear about competences and competencies and are told that competence is quite different from competency and the two terms should never be confused" [19]-[49].

Educators usually define competences as indicators of profits, knowledge and capacities while, on the other hand, employers and economists associate them to the performance, productivity, efficiency and professionalism [20].

The term "Competencies", "Competence", and "Competent" refer to a state or quality of being able and fit. Some English dictionaries describe the word competence as the quality or state of being suitable, sufficient, or fit and for competency refer to competence. However most of them make the following distinction: competence means demonstrating the knowledge, skills, experience, and attributes necessary to carry out a defined function effectively and competency alludes to the description of the knowledge, skills, experience and attributes necessary to carry out a defined function effectively. In other words: competency seems to be a description of behaviour, and competence a description of work tasks or job outputs. We embrace distinguishing these two concepts in such a way that competence and competences refer to broad capacities; in contrast competency (plural competencies) is a narrower, more atomistic concept used to label particular abilities.

It is not strange that competences mean different things to different people since, by means of a short bibliographical insight, we have found three historical approaches in its use: in the psychological field, in the business/human resources field and in the educational field. From these, the last two ones, competence organizational-training and competence-based teacher training, seem to be the principal approaches and were developed in the United States having a wide and similar development in United Kingdom and Australia [19]-[21]-[22]. In fact the origin and development of the competence movement specifically within the educational field is not clear. During the Sixties and Seventies, the "competency movement" was characterized by detailed analysis of professional tasks and job tasks were dissected into long lists of behavioural

elements. Thus, competence-based education became primarily associated with behaviourism and modular teaching in skill-based instruction [23].

Grant et al. [24, p. 6] in 1979 defined competence-based education as "a form of education that derives a curriculum from an analysis of a prospective or actual role in modern society and that attempts to certify student progress on the basis of demonstrated performance in some or all aspects of that role", concluding that competence is a broad term, and that the programmes based on competences can be very diverse with respect to their theoretical orientation, their scope, their intentions and their scientific focus. These scopes of competences, primarily centred in programmed instruction models, went progressively enriched with contributions of the cognitive learning theories [10].

In the Nineties pedagogical innovation, new methodologies, assessment learning and quality of the education grew up and got a critical position on competence-based education, which programmes have the drawback of a rigid mapping and its untouchable starting point for the definition of occupational competences, leading to routine job descriptions in which the proactive and reflective worker is left out [25]. Competence-based training was considered appropriate within a Taylorist management environment, but seem to be inadequate for nowadays society, where the industrial base is supplanted by the "knowledge economy". The new scenario of the highly-skilled workplace requires a more holistic approach, centred in flexibility and problem-solving abilities, with a different and more active role of the worker [26]. Cross & Israelit affirm that "Today's knowledge worker is valued precisely for his or her ability to contribute with unique knowledge, skills and perspectives –a highly subjective process that, at best, can only be developed when technologies form the heart of what most organizations are calling knowledge management" [27].

In addition, competences in education may be viewed from theoretical, operational and holistic perspectives. From a theoretical perspective competence is defined as a cognitive structure that facilitates a specific behaviour. From an operational perspective, competences seem to cover a broad range of higher-order skills and behaviours that represent the ability to cope with complex, unpredictable situations; this operational definition includes knowledge, skills, attitudes, metacognition and strategic thinking, which presupposes conscious and intentional decision making [10]-[26].

A holistic vision (global approach) of the competence does appear when constructivism reigns and the context acquires special relevance. According to Stoof et al. it is necessary to determine the viability of the competences for which they propose the use of three variables as prerequisites: people, goal, and context [15].

Sullivan emphasizes framing competencies (and outcomes) around three apprenticeships -- head (intellectual development), hand (skill development) and heart (modes of thinking, habits of mind) [28].

Finally, another problem arises when educators focus on the method on how to teach competences rather than what competences should our students learn? At what dimension and level? All these considerations determine the existence of great difficulties for the curriculum design.

3 Approach to competence meaning within EHEA

From the previous section we deduce that competence is a polysemic word and has been defined and used in a variety of areas along the last four decades [29]. And in context of the educational field this term has frequently been used as student outcome, learning outcome, objective, skill or ability among others [26]-[30].

Despite some attempts (e.g., IEEE Learning Technology Standards Committee, ABET, Tuning and Deseco Projects, etc.) having been done, there are still different definitions and methodologies associated to competences [11]-[30]-[31]-[32]. And so we find, for example, that social competences (that tend to be intangible) are frequently understood in a different way from the technical ones (that tend to be more tangible). On the other hand, its conceptual meaning also varies throughout different countries and cultures. It is not clear if the competence refers to what the people are able to do, they should be able to do, they must do or they will really make to achieve professional success. This confusion often reflects inconsistent usage of terms as much as different cultural traditions or epistemological assumptions [30]. A tacit understanding of this “fuzzy concept” has been overtaken by the need to define it precisely and to establish a minimum consensus, but the practical has become shrouded in theoretical confusion and the apparently simple has become enough complicated [33]-[34].

Mansfield contrasts three different usages of competence: outcomes (vocational standards describing what people need being able to do in employment); tasks that people do

(describing what currently happens); and personal traits or characteristics (describing what people are like) [35]. In a recent report the Centre for European Research on Employment and Human Resources has presented a prototype typology of knowledge, skills and competence (KSC). In words of Winterton et al. while a person may have the skills or knowledge (competency) to perform a task, this does not mean that he or she will have the desire (attitude) to do so correctly (performance). In other words, competences give a person the ability to perform, while attitudes give a person the desire to perform [30].

Employers demand graduates who are able to operate in complex environments, e.g. environments characterized by ill-defined problems, contradictory information, informal collaboration, and abstract, dynamic and highly integrated processes. The concept of competence is strongly associated with the ability to master such complex situations and for this reason it is assumed that "competence" transcends the levels of knowledge and skills to explain how knowledge and skills are applied in an effective way [10]. Competence includes high-order abilities related with being able to learn, adapt, anticipate and create, rather than being able to demonstrate that one has the ability to do [36].

In the project "Tuning Educational Structures in Europe", "Tuning Project" for short, coordinated by the University of Deusto in Bilbao (Spain) and the University of Groningen (The Netherlands), competence is defined as "a dynamic combination of attributes - with respect to the knowledge and its application, to the attitudes and responsibilities that describe the results of learning a determined program, or how the students will be able to develop at the end of the educative process" [11]. Tuning Project makes the distinction between learning outcomes and competences to distinguish the different roles of the most relevant players: academic staff and students/learners. Desired learning outcomes of a learning process are formulated by the academic staff, preferably with student representatives also involved, on the basis of input of internal and external stakeholders (employers, graduated, etc.), while competences are obtained or developed during the process of learning by the student/learner. Both competences and learning outcomes can be identified and related to whole programmes of study (first or second cycle) and for individual units of study (modules), specifying the requirements for award of credit.

4 Competence-based education initiatives in Spain

In contrast with a long experience and background in other countries, competence-based initiatives in Spain are at the early stages of development.

The most commonly assumed scopes of initiatives have been taken following the Tuning Project which provides a methodology that produces "reference points" for faculty developing statements of learning outcomes, levels of learning, and desired competences in the disciplines so that those statements are clear and easily comparable. It seeks to assist institutions and faculty in describing cycle degree programs at the level of subject areas and to establish a "common language" that expresses what a curriculum design at a specific institution aims to do, but does not prescribe the means of doing it, thus the Tuning notion focuses on "convergence."

For this project a review of over twenty studies in the field of generic skills and competences was carried out, identifying a list of 85 different competences. They were classified into two types: generic or transversal competences which in principle are subject independent, and subject specific competences.

The so called *generic competences* identify shared attributes which could be general to any degree, such as the capacity to learn, decision making, communication abilities, project design, teamwork and management skills, etc. which are common to all or most of the degrees. And the *specific competences* play a crucial role to prepare students for the profession or the type of jobs for which the educational program prepares. The generic competences were in turn well categorised as instrumental, interpersonal and systemic competences (see Tuning Project, p. 70).

—***Instrumental Competences*** include:

• *Cognitive* abilities, capacity to understand and manipulate ideas and thoughts.

• *Methodological* capacities to manipulate the environment by organising time and strategies of learning, making decisions or solving problems.

• *Technological and* management skills related to use digital devices, computing and information systems.

• *Linguistic* skills such as oral and written communication or knowledge of a second language.

—***Interpersonal Competences***: *Individual* abilities concerning the capacity to express one's own feelings, *and social skills* such as interpersonal communication, team-work or an active attitude in order to get social and ethical commitment. These competences tend to favour processes of social interaction and co-operation

—***Systemic competences*** include those skills and abilities concerning *whole systems*. They suppose a combination of understanding, sensibility and knowledge that enable to see how the parts of a whole relate and come together. These capacities include the ability to make improvements and design new systems. Systemic competences require the prior acquisition of instrumental and interpersonal competences.

In 2002 the Spanish Ministry of Education founded the National Agency for Quality Assessment and Accreditation (ANECA), whose first task was to encourage universities to implement conversion projects for syllabus and degrees conforming with EHEA. For the elaboration of these projects (called *White Books*) it has been considered high-priority to approximate the required competences from the perspective of the different stakeholders: employers, academic, graduates, students and other social agents. The official document provided by the Ministry of Education, called *"The integration of the Spanish Higher Education System in the European Higher Education Area"* (2003), affirms that the official degrees will have to provide a university formation in which the generic (basic) competences related to the integral formation of the people are harmonically integrated with specific competences that make possible a professional profile and enable the graduates to get integrated into the job market [37].

5 Competences mapping in engineering curriculum

5.1 The context of the School of Design Engineering

Throughout the last decades, Spain has undergone a profound social and economic change that has greatly affected its higher education system whose structural reform has modernized universities and brought democracy on them. Despite these facts the actual academic culture, including the formative processes in which teachers and students are involved, is not giving a suitable answer as the new situation requires yet.

Within this scenario, the School of Design Engineering (ETSID) at Polytechnic University of Valencia (Spain) which has approximately got 3.500 students with 310

academic staff and 30 administrative staff, has been involved, for many years, in a deep process of global quality assessment and improvement. This process has always kept three major fundamental priorities in mind: a) Educational Innovation; b) Close relationship with the socioeconomic and industrial environment; and c) International Relations. Hence ETSID has got some strong pillars that somehow facilitate the European convergence and the Bologna Process, [40].

5.2 Experience of adaptation to EHEA at ETSID

During the 2003/04 to 2005/06 academic courses, several projects in engineering education to adapt the EHEA at ETSID were implemented, involving curriculum development and faculty enhancement. The aim of these projects was:

(a) to establish a curricular structure for competences-based and well-defined professional profiles,

(b) to adapt the formative programs according to the ECTS recommendations and requirements,

(c) to develop curriculum materials to meet key competences and learning objectives, increasing the use of active methodologies with continuous and formative assessment, (d) to elaborate information documents about the study programs and the results of the students in normalised format (Information Package); and

(e) to manage an action agenda in the gradual implementation of the changes (surveys to institutions, employers, students and administrative staff). In Figure 1, we show the flow of this process.

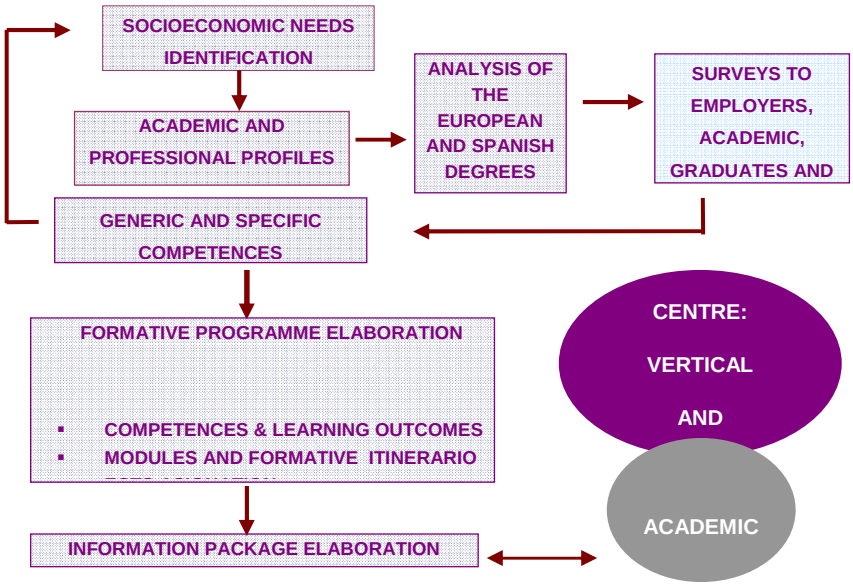

FIGURE 1 Scheme of design degree in the Projects Adaptation to EHEA

The project development paid special attention to the staff participation since previous studies had shown the lack of success of innovation projects due to the failure of teachers to implement the intentions of the developers [38]. In order to reduce the chances for this might happen at ETSID, leading administrators presented the project to the whole centre (academics, students, administrative and other personal), specifying the different phases and organizational structure, discussing the strategies, planning the tasks and encouraging them to conceptualize and suggest changes if considered adequate.

A diagnosis of the situation was simultaneously made with the initial actions in the projects undertaken. Surveys to professors and students were applied to evaluate their degree of information on subjects concerning European convergence and ECTS [39]-[40]. Table I and Figure 2 shows a list with the obstacles and difficulties in decreasing order of importance for the adaptation to the European Credit Transfer System indicated by the 37 teachers that answered the survey out of the 69 whom it was sent out [40].

a	Large classes, with an excessive number of students.
b	Determination of student workload.
c	Active methodologies application.
d	Change in assessment methods.
e	Definition and application of competences.
f	Reorganization of physical and human resources.
g	Determination of curriculum goals.
h	Need of new spaces resources (TIC, seminar rooms, etc.).
I	Contents reorganization.
j	Poor information about the Bologna process.

Table 1. Teachers' concern about obstacles and difficulties for ECTS adaptation to ECTS (N= 37)

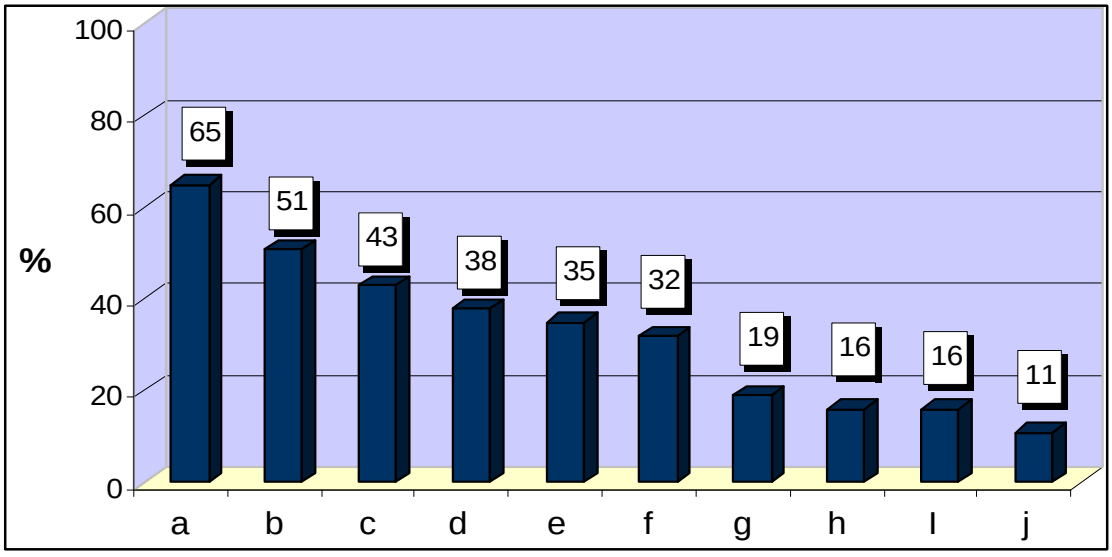

FIGURE 2 Percentage of concerns relative to the items of Table I

In the student samples, the ignorance on EHEA issues was very high as shown in Fig. 3, which represents the number of affirmative answers to the question: "Do you know the meaning of the expression European Higher education Area?"

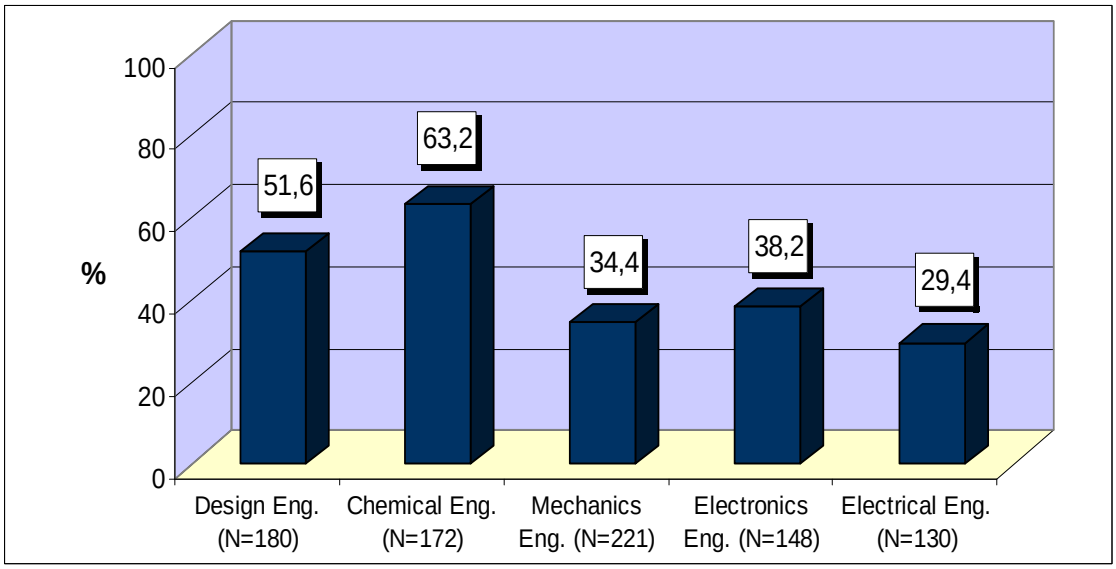

FIGURE 3 Students knowledge on the meaning of EHEA (N = 180 Design Eng.; N = 172 Chem. Eng.; N = 221 Mech. Eng.; N = 148 Electronics Eng.; N = 130, Electrical Eng.)

Hence only in the Chemical and Design Engineering cases more than half -63.2% and 51.6%, respectively- of students affirmed to know the meaning of EHEA.

The results were worse when the students answered the question: "Do you know the European Credit Transfer System?" We may observe in Fig. 4 that only 37.3% of Design Engineering students responded affirmatively to this question, 14.5% in the Electronics case, 8.4% in Mechanics, and 7.6% in Electrical Engineering. Anyway it is surprising that even students that know about EHEA, do not know about ECTS [40].

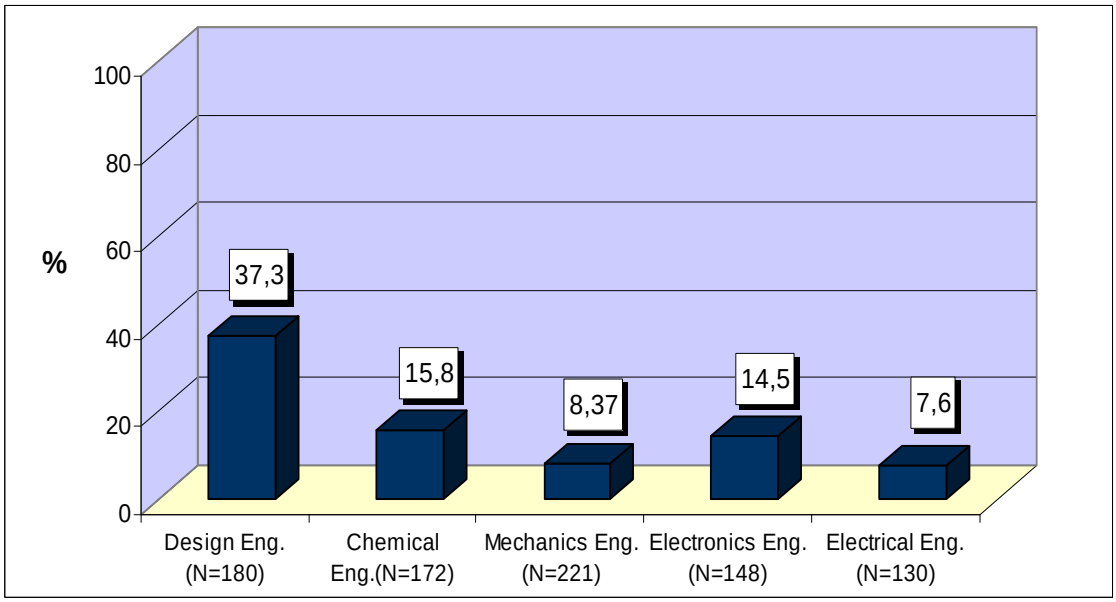

FIGURE 4 Percentages of engineering students that claim to know ECTS

Having in mind these difficulties, we provided enough time to enable participants to fully reflect upon potential profiles and reach consensus. A competition of posters was also organized in order to provide an institutional slogan, as well as awareness working weeks specifically oriented to the students. The exhibition of the awarded posters was run for a month, delivering explanatory booklets with EHEA information.

With the aim to improve the participation and involvement of the academic staff, formal workshops were organized allowing staff to experiment with new ideas, providing informed advice from experts about how they might strengthen their definitions of competences. These workshops were usually offered on a regular, consistent basis with follow-up discussions and meetings rather than a single event [39].

Simultaneously, we reviewed multiple sources of information about competences, the Tuning approaches being the most relevant along the ABET EC-2000 criteria, results of the CHEERS survey and IEEE Learning Technology Standards [5]-[11]-[31]-[32]-[41]. Therefore, competences were established, understood and accepted. At this point, faculty and staff began to re-evaluate the curriculum and moved toward identifying and articulating relevant and current competences. Thus we started with an up-down method criteria and tried to reach a first approach to a core set of competences with bottom-up input.

5.3 Competences mapping

We define competences mapping as the process of identifying key competences for a particular degree within an institution. The key process of this "competence mapping" method has been a gap analysis between the most required competences and the highest deficits in the majority of European countries, particularly in Spain [5]-[7]-[11]. With the relevant competences pre-identified in the pilot projects called *White* Books in Spain, we elaborated a list and asked faculty and the different stakeholders to identify the most important areas within the curriculum. The results that we obtained in a set of surveys applied to employers (N=994), graduate students (2085) and academics (N=1423) are included in Tables 2-4.

Competences	**X**
Problem-solving (ability to identify, formulate, and solve engineering problems)	3,41
Decision-making	3,40
Planning, coordinating and organizing	3,39
Ability to apply knowledge in practice	3,30
Team-work	3,26
Motivation for quality and continuous improvement	3,26
Capacity of analysis and synthesis	3,22

Table 2. Ranking of some generic competences (N = 994 employers) - Importance level (4=most important to 1=least important)

Competences N	**X**				
	El (630)	**E (520)**	**M (600)**	**C (250)**	**D (85)**
Problem-solving	3,55	3,55	3,50	3,63	3,50
Ability to apply knowledge in practice	3,67	3,48	3,48	3,67	3,48
Basic knowledge	3,61	3,49	3,40	3,46	3,40
Innovation	3,36	3,40	3,34	3,38	3,34
Inititative	3,52	3,37	3,33	3,38	3,33
Team-work	3,33	3,19	3,16	3,2	3,16
Decision-making	3,36	3,24	3,14	3,25	3,14
Leadership	3,21	2,96	2,98	2,96	2,98

Table 3. Generic competences ranking. N = 2085 graduates: 630 Electrical Eng.(El), 520 Electronics Eng.(E), 600 Mech. Eng. (M), 250 Chem. Eng. (C), 85 Design Eng.(D)

Competences	**X**
Ability to apply knowledge in practice	3,47
Basic professional knowledge	3,44
Ability to understand professional and ethical responsibility	3,42
Ability to function on multidisciplinary teams	3,41
Critical reasoning	3,34
Problem solving	3,26

Table 4. Ranking of some generic competences (N = 1423 Academics)

Thus we find that the ability to identify, formulate and solve engineering problems occupies the first place for employers and graduates but appears in sixth place for academics. These results are coherent with the actual university model of transmission of knowledge, with a deficit in development of competences related to practice abilities and attitudes. Another weakness, for example, is that the knowledge of a foreign language does not appear at the top of this ranking, despite this competence is directly related to the European convergence goals (mobility).

With this ranking of competences and following the process schematized in Fig. 1, academic staff has made key decisions about the best way to modify, shape, and ultimately improve the academic program by explicitly linking their competences across several levels. Competences were embedded within individual courses and also aligned with the overall goals of academic programs.

We consider that competence-based educational initiatives should be embedded within a larger institutional planning process and these linkages -align competences with coarses goals- are crucial for the coherence in the curriculum [43]-[44].

Many institutions in Europe claim to have a competence-based curriculum. However in many cases only superficial changes in the curriculum have taken place and learning processes have not changed in practice. But as Adelman says: “What credits based on student workload do (at least if faculty reflect deeply as opposed to mechanically) is to spur changes to the shape and delivery of curriculum” [12, p. 61]. For this reason we consider that it is necessary to redraw the curriculum with interdependent feedback loops, constructing a map of competences downwards from top and upwards from

bottom after determining the core competences by deliberation and through a partaking process.

In Table 5 and Fig. 5, we show the examples of the first approximation to "core" competences developed in Electronic Engineering.

a	Ability to function on multi-disciplinary teams
b	Ability to use the techniques, skills and tools for engineering practice issues
c	Basic professional knowledge
d	Information Management
e	Ability to design and conduct experiments, as well as to analyze and interpret data
f	Ability to apply knowledge of mathematics, science, and engineering
g	Ability to identify, formulate, and solve engineering problems
h	Communication with other expert areas
i	Appreciation of diversity and multiculturality
j	Capacity of independent learning
k	Ability to design and with project management
l	Understanding of professional and ethical responsibility

Table 5. First approximation to "Core" competences in Electronic Eng. Curriculum

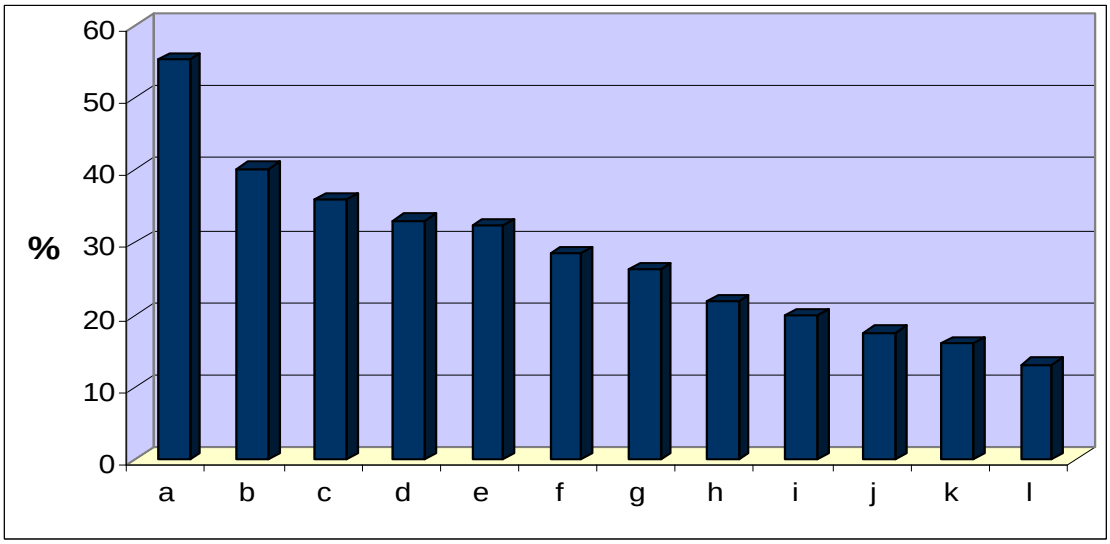

FIGURE 5. Percentage of the "core" competences embedded into Electronic Eng. curriculum (N= 57)

We observe how instrumental competences prevail over interpersonal and systemic competences. Most universities in Spain are still centred in competences and cognitive outcomes related to knowledge acquisition, showing that the change of paradigm is hard to get.

The Spanish legal framework for the implementation of the main instruments included in the statements and communiqués of the Ministers responsible for Higher Education in Bologna (1999), Prague (2001) and Berlin (2003) has been fulfilled. Rules concerning the use of the European credit system (2003), issuing the Diploma Supplement by Universities (2003) and the validation and assessment of study programs and official degrees (2004), are already in force. The Government has approved (January 2005) by Royal Decree the two basic regulations for the establishment of a new structure of Higher Education programs and has opened the process of renewal of the study programmes in three levels: Graduate, Master and Doctorate. This Royal Decree establishes the three Bologna cycles comparable in duration to those existing in other European countries and will lead to a reduction of the content of core curriculum, which will be based on learning outcomes and competences.

At present, we are working in a second stage of deepening, enriching the "core" map of competences (and including competences related to fluency in foreign languages). Indeed we are addressing the following questions:

1) Where in the curriculum and at what level do students learn and practice these competences? (competences itineraries)

2) What teaching strategies and assignments are given to students in order to help them developing these attributes?

3) What assessments (methodologies, resources and instruments) are to be selected to determine if students are mastering the competences?

4) How to develop and improve indicators in order to guarantee the expected learning outcomes? (assessment & quality assurance)

6 Conclusions and comments

Competence-based education and more specifically competence-based learning is the leading paradigm for innovation in knowledge societies. The concept of competence (and learning outcomes) becomes the basis for the redesign of future curriculum

proposals in Spain in the same way as in several European countries. Although the prevalent conceptual perspectives of competence-based learning in Europe are associated with constructivist theories of learning, there is confusion, debate and increasing criticism concerning the concept of competence. At present it is impossible to identify or impute a coherent theory or to reach a definition capable of accommodating and reconciling the different ways in which the term is used and we can say that there is no theoretical framework for competence. Since reform is approaching educators and trainers are in the early developing stages trying to explore the meaning and implications of competences and learning outcomes in practice.

Our experience has enabled us to establish a set of "strong principles" or key considerations in the decision-making process to define map competences. They hatch by paying attention to concerns about validity and reliability of competences, while institutions can glean meaningful information to improve their initiatives by asking and improving the participation of different stakeholders. Potential participants include the faculty, academics, graduates, students, and employers who hire the program or institution graduates. We consider that once faculty have identified and reviewed relevant and potential competences, they must determine the best strategy in order to get formal feedback from their own constituencies. These formal strategies to identify the relevant competences are typically research-based and require a systematic analysis of results in order the information to be meaningful, useful, and valid. Participation, commitment and critical reflection of the educative community are the mechanisms to construct a community of practice and to put competences development from "theory to practice".

A major challenge for teachers (and students) is to ensure that competences are both valid and reliable with the ultimate aim being, in practice, that they are fully transportable throughout and outside the institution. But up to now this standardization of terminology and semantics across European countries is difficult to carry out.

It is not clear how problems related to transportability of competences assessment and credentials across states and institutions will be solved. There is a need to keep paying attention to transportability learning issues, as well as to associated experiences across academic programs and institutions by focusing on how reliability and validity of competences and its assessment are addressed. The success of the Bologna process in

Spain depends upon an institutional change of academic culture and improving the new paradigm of competence-based education will require some time.

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