International Journal of Engineering Education Vol. 31, No. 1(B), pp. 184–198, 2015
Printed in Great Britain

0949-149X/91 $3.00+0.00

Promoting Professional Project Management Skills in Engineering Higher Education: Project-Based Learning (PBL) Strategy*

IGNACIO DE LOS RÍOS-CARMENADO
Projects and Rural Planning Department, Higher Technical School of Agricultural Engineering, Technical University of Madrid, GIE- Project. Research Group GESPLAN. E-mail: ignacio.delosrios@upm.es

FERNANDO RODRIGUEZ LÓPEZ
Civil Engineering in Construction Department, Higher Technical School of Civil Engineering, Technical University of Madrid, GIE-Project. Research Group GESPLAN. E-mail: fernando.rodriguez@upm.es

CRISTINA PÉREZ GARCÍA
Agroforestry Engineering Department, Forest Engineering School, Technical University of Madrid, GIE-Project, Research Group GESPLAN. E-mail: mariacristina.perez@upm.es

The objective of this paper is to address the methodological process of promoting professional project management skills in Engineering Higher Education, evolving from Graduate to Postgraduate Programs. The strategy was born from a cooperative model of Project Based Learning (PBL) created with the experience of the GIE-Project, Educational Innovation Group (EIG) of the Technical University of Madrid (UPM), in collaboration with other EIG and industry stakeholders external to the university. The model has evolved and undergone various phases until being inserted in the European Space of Higher Education with the International Project Management Association (IPMA) competences. Over time GIE-Project strategy has developed into a process, an approach to designing, developing, implementing, evaluating and promoting professional Project Management skills in first (Graduate), second (Postgraduate) and third (PhD) cycle degree programmes. The results show how phasing in teaching aimed across different educational levels facilitates a gradual training in the 46 elements of professional competences required to obtain the IPMA's certification on Project Management. The educational strategy is conceived as a new teaching dimension within the framework of the EHEA, taking the course projects—Preliminary course, Final Degree Course Project and Final Master's Course Project—as an educational component suited for generating a "pre-work experience" to link teaching activity to the business and industrial environment. This paper shows the main success factors in the process that was carried out: the links between teaching-professional certification, the evaluation of professional competences, Project Based Learning, teaching subjects in connection with real-world problems, cooperative learning, mobility activities and integration and applied teaching-research.

Keywords: professional skills; Engineering; higher education; assessment and certification of professional competencies; cooperative education; project-based learning

1. Introduction

Since late last century, a European Higher Education Area (EHEA) is proposed within the European Union. The EHEA proposes a new methodology for educational learning and invites to implement a model based on the development of competences. The purpose is providing students with certain competences that allow them to keep learning and find by themselves new knowledge paths and acquire problem solving abilities. Equally, it aims to improve technical education and give training to future professionals, giving them combined skills that helps both, the academic scope and the professional one [1]. Currently, we are involved in a wide-reaching process of reflection and change oriented toward promoting a qualitative leap in the educational model of European Union universities stemming from different agreements reached in the EU to construct a EHEA that will be the basis of a new knowledge-based economy that responds to the challenges of globalisation [2]. One of the greatest challenges the university's system has to face is to demonstrate a strong adaptation capacity to the changes in today's society and its new demands, and where the concept of profession focuses on what are called professional competences. To solve the enterprises' problems, technology is not enough; instead more humanism is necessary. Engineering education has to give technical knowledge and capacity, and the flexibility and understanding of the social context where it is located [3].

On the other hand, the American Society for Engineering Education (ASEE) says that engineering education should not only focus on theory and experimentation, it has to have relevant, attractive and with connected programs that prepare the students for continuous learning [4]. In this new

* Accepted 15 July 2014.

context, the conception of competences constitutes the essential foundation in the professional world, and therefore, it becomes a key element of any educational model. Today, enterprises demand for experimented experts, more than competent professionals. Moreover, in the sphere of the EHEA it is stressed that one of the measures necessary for achieving employability is developing transversal skills and competences, such as communication and languages, the ability to handle information, to solve problems, to work in teams, and to lead social processes. Based on the context of engineering professional practice, the implications of its teaching are relatively clear. We must firmly focus the education in the timeless aspects of the professional context: focus on the customer's needs, products and systems delivery, new inventions and technology incorporation, contribute to the development of their products and do it while working in engineering organizations. It is implicit that, the engineering alumni shall evolve as reflective and matures individuals [5].

1.1 Professional competency for engineering programs

The evolution of the concept of professional competences has been developed in various stages, taking into account various historical contributions of the concept, as well as an open, flexible, and trans -disciplinary perspective. Competence is an amplification of the concept of ability and qualification resulting from the rapid technological evolution in work organization and planning activities [6]. *Professional competence* is thus the sum of the essential competences for well carrying out a professional task. There are certain qualities, beliefs, characteristics and skills that give an individual the potential to develop the behaviorisms that permit the individual to successfully complete his role in a particular organization [7]. Professional competence is a package of knowledge, attitude, skills and relevant experience, which is required to be successful in a particular job [8].

Among all the professional competence approaches, the holistic approach defines professional competence as the result of a mixture of personal underlying issues, as communication, self development, creativity, problem solving and analysis; all of them set as target competences, as they allow the existence of cognitive, functional, behavioural and ethical-value competences that in general determine professional competence [6]. Without any doubt, one can say that in the knowledge based society of the new millennium, the profile of a good engineer has to be based on: capacity and will to learn, solid knowledge of the basic natural sciences and the deep knowledge of some technology area, besides the general human values. Moreover, the engineer has to be prepared for permanent learning as well as being capable of communicating and team-working. Technical competences are not sufficient for today's world [9]. The engineer must take advantage of new opportunities and the technical education of the future has to be more integrative. In this context arises the interest of the Massachusetts Institute of Technology (MIT) on having support to build a frame of appropriate generic competences and curricula that develop competences, as they believe that today engineers should be involved in all stages of the product's life cycle system. The CDIO (Conceive, Design, Implement and Operate) proposal is based on the certainty that higher education's role is educating students to be modern engineers, capable of participating and eventually becoming leaders in conception, design, implementation and operation of the cycles where their activity is developed. To do so, the alumni have to be technical experts, socially responsible and innovative. This CDIO's system initially developed by the MIT and the Swedish University of Chalmers today is used in almost 40 engineering programs around the world; it defines a list of competences (syllabus) in different levels, and promotes the competences learning as a context for the development of subjects [10]. CDIO's proposal defines a list of competences (syllabus) in several levels. It Sets a product's life cycle as the ideal environment for engineering education and promotes competence learning as a context for module development. This list of competences is divided in two groups: a group of five "hard" skills and a second group called "professional" skills. The 11 ABET criteria, show a codification in basic competences that is useful for accreditation and is considered indispensable for engineering graduates. ABET defines a way towards an engineering educationist excellence which is integrative and responsible [11]. The "hard skills" are *a, b, c, e* and *k*, while the "soft" ones or professionals are *d, f, g, h, i* and *j*: (a) an ability to apply knowledge of mathematics, science, and engineering; (b) an ability to design and conduct experiments, as well as to analyze and interpret data; (c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability; (d) an ability to function on multidisciplinary teams; (e) an ability to identify, formulate, and solve engineering problems; (f) an understanding of professional and ethical responsibility; (g) an ability to communicate effectively; (h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and

societal context; (i) a recognition of the need for, and an ability to engage in life-long learning; (j) a knowledge of contemporary issues; (k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice [12].

1.2 Engineering and Professional Project Management skills

Contemporary project management practice demands that engineering professionals not only master engineering, as well, they should know about technical concepts and have a strong background on project management methods. Project management is now big business. International tendencies show that professional project management skills are seen as a key element and include concepts such as: benchmarking, maturity, certification, learning and knowledge [13, 15]. Today Project Management graduates and postgraduates find a wide range of employment opportunities in all industries and the public sector, especially in engineering consulting, construction and energy firms, as well as in the public sector [14].

Project management trainers and researches have put more emphasis on the rational models—"hard systems" models—focused on the technical project dimension, especially on planning and control [16]. Other researches prove the importance of social sciences on project management models, integrating organization behavioural competences [17, 25, 26, 28]. In addition, other trainers and researchers recognise the importance of project management models to integrate contextual competences that consider the exogenous factors that influence the projects [16, 29, 30].

In an increasingly global economy, project engineering professionals need guidance to help them understand the basic principles of managing projects. International standards can help those involved in projects to improve the success of a wide variety of project types. ISO 21500 is the first in a planned family of professional project management standards. It is also a basic guide, aimed at the informed reader without an in-depth knowledge of project management [19]. IPMA has defined a group of competence elements for Project management, with a holistic an detailed approach, that makes it suitable to serve as base in determining the competence codification required by a superior education graduate. It is a universal certification model for project management skills at the four IPMA 4LC levels. The IPMA's universal certification model for 4LC skills is applied in 50 countries through their respective national accreditation bodies, and is based on the IPMA's ICB3 Competence Baseline V3 and the National Competence Baseline NCB.V3 [20]. At the time of writing this study, fifteen NCB3s were identified in fifteen different languages, and all of these contain a minimum of 3 parts and 46 skill components of the ICB3. The comparison between CDIO and IPMA shows that IPMA contains the ones found also in CDIO [1]. This allows to use IPMA codification in the competences definition of an engineering student being confident that the ABET certification will be passed.

1.3 Project-based learning and competency—based approach

On the other hand, within this general framework, numerous studies around the world have proposed project-based learning [21, 22] as the most suitable means of achieving effective engineering competence-based education [37, 38, 39] that integrates knowledge, skills and values. The models integrating project-based learning have their scientific basis on generating learning processes in which students are not passive recipients of knowledge [21]. Following the trends of the psychology of knowledge, project-based learning is grounded in the belief that humans construct new knowledge on an already established base of what is known and has been experienced, which is made available through active participation and interaction with others [23, 24].

This paper presents a methodology of cooperative education, which was applied over 20 consecutive years and which integrates the scientific basis of project-based learning (PBL) in Engineering Higher Education. Over this extended period, we were able to extract the main advantages and difficulties that have appeared during the process, from its initial phase as an innovative pilot experience in an undergraduate course, up to its consolidation within an entire educational strategy completely adapted to EHEA that covers both undergraduate and graduate programs.

2. Project-Based Learning (PBL) strategy: teaching-learning methodology

In 1987 an educational methodology was applied with students of the fifth year of the program of the Agronomic Engineer Technical School of the Technical University of Madrid (Universidad Politécnica de Madrid), fruit of a collaboration agreement for integrated studies in region development, between the ETSIA Department of Projects and Rural Planning and the Government of the Community of Madrid. This agreement and the subsequent projects implemented in the course of twenty years were the foundation for consolidating the project-based learning approach that has permitted adapting methodological aspects developed in teaching to real problems. Over this extended period (20 consecutive years) the main advantages

and difficulties that have appeared during the process have been extracted [23]. Currently, the PBL-strategy is inserted into a full process of adaptation of the university to EHEA, consequent with the challenge of converting the European Union into a society based on more competitive and dynamic knowledge [2]. This demands for new models of educational innovation based on competences and aptitudes; it implies new course designs and new learning objectives, affecting both teaching-learning methodologies and evaluation.

In this new context the PBL-strategy is based on the implementation of one *Educational Innovation Program* (EI-Program) for promoting professional Project Management skills in Engineering Higher Education. This strategy is part of the adaptation process to the EHEA in the UPM. In the former changing context, the EIP has its origins in the policies adopted by the UPM to promote the restructuring of university as a strategic line of action of all the Colleges within the Technical University of Madrid. For this restructuring, the UPM decided, as main line of action, to promote "*Educational Innovation Groups* (EIG)". This body was established as an original investment in the current university scene. Within this framework and following the first UPM call for EIG, the *EIG-Project* in 2005 was officially approved as a group set up by people that show a career, experience, training and a future project of sufficient consistency in the fields of engineering and professional project management skills. *EIG-Project* starts with the main objective of conceiving a new teaching dimension around Projects as educational elements suitable to generate an early professional experience and training from competences [25].

In order to obtain the strategic objective to develop the competences from the international standard perspective [20], the EI-Program has different phases, being implemented trough the EI-Projects. These EI-Projects may be renewed annually subject to satisfactory progress and results. The renovation requires the external evaluation of the EI-Project, on the part of an independent Advisory Committee, incorporating learning processes with the application of participatory techniques [26]. This approach has also enabled achieving the following objectives: (a) making knowledge and experience of those involved the main source of information for program management [15, 27]; (b) encourage the learning of all actors [18]; (c) focus changes from the beneficiaries of the actions viewpoint [28]. The following scheme (Fig. 1) shows the process followed in the EIP implementation according to the program management phases [29]: (1) Initiation, (2) Definition and Teaching Planning, (3) EI-Projects delivery (Teaching and Assessment) (4) Review (Learning) (5) dissolution.

Table 1 shows the process followed in the EIP, since the formal approval of the interdisciplinary team teaching (Innovative Education Group, IEG) in 2005. After 20 years, in which the strategy was validated for under-graduates, the change in curriculum in this university and the adaptation process to the EHEA in 2005 constitutes the beginning of a new phase. In this period, the application of the PBL strategy was extended to postgraduates. This way, PBL strategy is used simultaneously for undergraduate—common core Projects, courses 4th and 5th year—and post graduate, Official Master and Erasmus Mundus "*Project Management and Rural Development.* The application of the PBL strategy has been carried out in Project's module lectures from different Schools of Engineering at the Technical University of Madrid. The findings focus on the evolution of this experience promoting professional Project Management skills in Engineering Higher Education, and broadening its scope to an entire educational strategy for undergraduate and graduate programmes.

3. Main results and findings: actual benefits for promoting professional skills

In this section the evolution of the PBL experience is reviewed. The findings and main results are shown

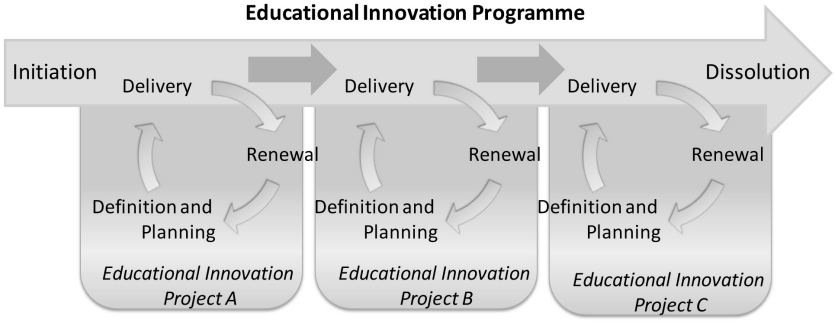

Fig. 1. Educational Innovation Programme: management phases.

Table 1. Process followed in the Innovative Education Group: EI-Project

Stages (Year)	Annual EI-Projects: goals and key objectives
2005–06	Interdisciplinary team teaching: external assessment and approval of the *EIG-project* as consolidated Innovative Education Group, set up by teachers related to Projects Engineering.
2006–07	New teaching dimension in Project Management, encouraging a multidisciplinary team and stable collaboration among Projects Engineering: incorporates the technical competences.
2007–08	Implement and validate an active methodology (PBL Project-based learning): in order to spread the contextual competences in Project Management in the *End of Degree Projects*, in collaboration with business and industry.
2008–09	Learning and assessment model which incorporates the behavioural competences in Project Management within IPMA international standards, reinforcing the comprehensive training of the students by the acquisition of competences and transversal values.
2009–10	The implementation of the news qualifications within the framework of the EHEA: reception and orientation process in the official Master's Program "*Project Planning of Rural Development and Sustainable Management*".
2010–11	Engineering Professional skills: Proposal of an operational model in the UPM.
2011–12	Design and the setting-up of a system for assessing the professional skills in the framework of undergraduate and graduated: implementation of the project management competences.
2012–13	Diffusion and dissemination: information for the whole university community, in co-operation with companies and other external stakeholders.

according to the EIP management phases: (1) Initiation, (2) Teaching Planning, (3) EI-Projects Delivery (outcomes) and (4) EI-Project renewal.

3.1 Initiation: international professional project management standards

Driving the previous teaching strategy into a new phase, the EI-project start has its background on the EHEA, European Research Area and the international professional Project Management standards. This background is organized accordingly to certain principles (quality, mobility, diversity, competitiveness) and it's oriented towards the attainment of two principal strategic objectives: (a) increasing employability and (b) the conversion of the ESHE a pole of attraction for students and teachers from other parts of the world. We also consider the international standards related to the professional Project Management skills: models of learning and Certification of Competences [20] and international standards for project management [19]. This model has been present in Spain since 1999, and is managed by the Spanish Association for Project Management's (AEIPRO) Project Management Certification Body (OCDP). This acts as a national association for the IPMA. It is a body, accredited by the National Accreditation Institute (ENAC), according to the applicable international regulations [19], which defines the necessary requirements for these organizations that certify people.

3.2 Teaching and learning strategic planning: interdisciplinary team teaching

On the other hand, interdisciplinary team teaching plays an important role in the planning of the strategy, which is composed of teachers, researchers and managers of international training programmes involved in the faculty and come from different departments with different technical specialties (Agricultural Engineering, Forest Engineering, Civil Engineering, Industrial Engineering, Technical Architecture, Public Works School). The opportunities for interdisciplinary cooperation [30, 31] where each professor provides a unique strength to the teaching teams: teachers are members of three recognized and regulated work structures in the UPM: *GIE-Project* (Educational Innovation Group), *GESPLAN* Research Group (Agriculture Faculty Technical School of Civil Engineering) and Research Group for Sustainable Management (*TECNATURA*, Forestry Faculty). *GIE-Project*, has as main goal the development of individual's skills, from the PBL—Thesis and Master Thesis Project—like an appropriate educational tool to generate professional experience strengthening cooperative learning [32, 33] and gradually addressing project management competences [30, 34]. Moreover, *GESPLAN* Research Group and *TECNATURA*, carry out research on Planning and Sustainable Project Management, which complements teaching and extends postgraduate studies. In the previous phases, work is pivoted directly and exclusively around the professors involved in the courses. Now, these professors are members of the Educational Innovation Group (GIE-project) and of the research groups; and many teachers and researchers involved in the Teaching and Learning Strategic Planning belong to both structures, facilitating the teaching-research integration within a learning strategy around Project Management Competences. This has brought about a substantial change: more or less independent courses become part of an entire educational strategy focused on project management competences through project-based learning. In any case, according to Robinson and Schaible [35], it is recommended that collabora-

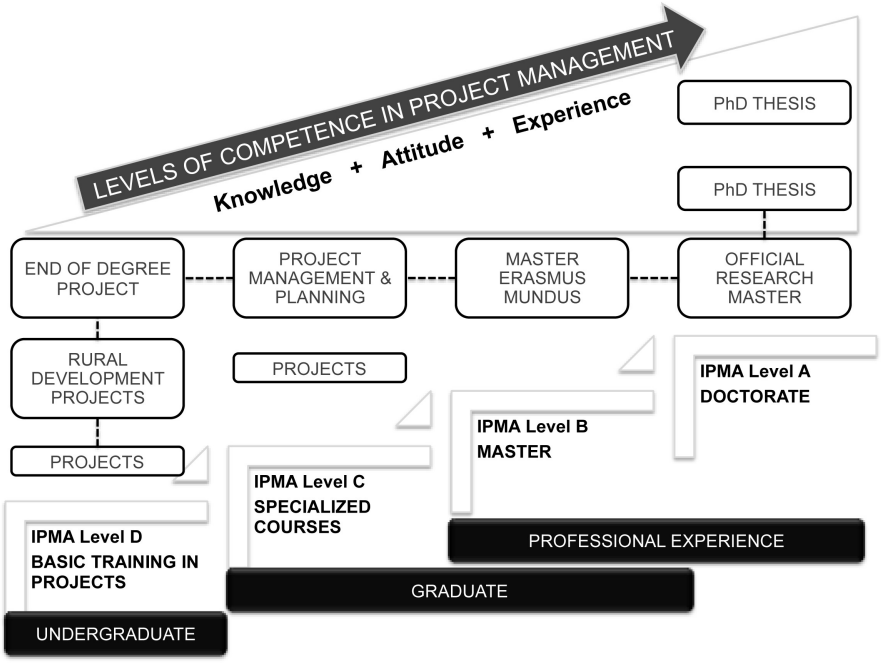

Fig. 2. Teaching and Learning Strategic Planning. GESPLAN-UPM.

tive team teaching be limited to two people, as good team teaching is too complex if performed by more than two teachers.

Figure 2 shows the Teaching and Learning Strategic Planning. The strategy extends to postgraduate education, including other actors-national and international- coordinated by teachers from GESPLAN, TECNATURA and GIE Project. This strategy should be aimed towards developing a *gradual process* of knowledge, values, and skills acquirement that students will be able to use early in his professional career by connecting the skills obtained on the project management's field. This way, teaching and research are integrated in a four level scheme, similar to the IPMA certification model, which gradually provides escalated training to students in the three spheres of professional competence. Their knowledge increases and their attitudes are shaped as they journey over this educational 'road'; they are given opportunities to acquire certain basic experience in advance, beginning with project modules that work as the basis of this methodology. This Strategic Planning includes the steps followed for integrating IPMA professional skills into educational programs. This integration involves a verification process for confirming that these programs comply with the criteria for being included in an enrolment system within the International Project Management Association (IPMA) 4LC certification model.

The IPMA model has become the central component around which the Erasmus Mundus program is built on, and is a tool aimed at improving employability for project management professionals. It consists of an integrated course, recognised by the EU for its quality in the European Higher Education Area, offered by a consortium of six universities across six different European countries: UPM (Spain), Montpellier (France), Wageningen University (Holland), Life University KVL (Denmark), University of Cork (Ireland), University of Catania (Italy). The international dimension of the teaching and learning planning strategy is reinforced in two ways: firstly by forming part of the international organization NATURA Network related with rural development and sustainable project management, and created in October, 1988 in Louvain-Belgium. Secondly, since 2006, the Masters program has reinforced its international dimension through Action 3 of Erasmus Mundus, establishing an association with 8 higher education universities in non-member UE countries. Through this action a higher world profile has been achieved, with a reinforced global presence, and associations with higher education institutions in non-member countries have been created. These relationships enhance the external mobility of students and academics, creating the Sustainable Development alliance. The characteristics of the teaching and learning strategy are thus enriched with the criteria emanating from the Erasmus Mundus programs: cooperation and mobility within higher education in order to achieve

the objectives of improving European higher education and promoting intercultural understanding through cooperation with non-member countries[1]. Erasmus Mundus reinforces European international cooperation within higher education in the field of sustainable rural development and project management. The phases of the process and the levels of the competences are summarized Fig. 2.

3.3 EI-projects delivery (teaching and assessment)

The teaching and learning strategy (being implemented trough the EI-Projects), is composed by the Educational Innovation Group and Research Groups team—GESPLAN, TECNATURA and *GIE-Project* providing professional contact with the external agents (project client). Students are included into this framework to participate in a learning process and solve real problems in teamwork project. During this process the students are enriched with external knowledge extracted from the direct contact with project stakeholders. These relationships and complementary information, allow students to enrich their knowledge base to build up new knowledge [23].

The teaching and assessment strategy amalgamated several activities in the project-based learning methodology [21]. In terms of the course syllabus, the content of the units integrated the knowledge of 46 competence elements needed for project management and problem solving [8]. Although technical competences are more relevant and essential for project management, contextual and behavioural competence elements are also considered. These activities, which have been defined as "early professional experience" [23] part of the idea of "learning by doing", learn from reality and extract adequate knowledge. Participation in projects with real content, which respond to real needs, gives students the opportunity to leave the classroom and get in touch with external agents to solve real problems. This characteristic is a dynamic element for the educational process where students learn to see how organizations-projects customer relationship actually works.

Teaching and learning processes respond to a logical structure according to the methodology phases in formulating and evaluating projects [34]. The development of engineering Projects lectures is basically a learning process designed to teach methodologies, which have an organic process where phases and concepts are linked to each other. This logical teaching and learning process follow four phases. Firstly, during the preparation stage for the project *formulation* (1) the task forces are set, the terms of reference are drawn up and the work plan is prepared. In the second phase, *analysis and diagnosis* (2), students role-play the different aspects of the specific situation of the project team. During this phase, students receive training on research techniques and analysis for the collection and examination of qualitative and quantitative data (analysis) to identify the main causes of the situation (diagnosis). At the end of this phase, all teams must identify possible proposals to improve the current situation and to answer the following question: have the needs and what needs to be done been understood for the project situation? Taking as reference the conclusions drawn during the analysis and diagnosis phase, teams proceed to the *project design phase* (3) for a more detailed and precise elaboration of the project to develop an investment proposal. During this phase, students receive training in design and planning tools in order to address the technical specifications of the project components. Although the specific level of detail depends on the nature of the project, all teams should proceed with emphasis on verifying systems, products and technology viability. They must also define the project's organization structure, its time program, resource management, and estimate costs and benefits. The main question that teams must respond at the end of this phase is, are we sure we know how to make the project work? After completing and documenting the previous phase, *multicriteria assessment* (4) examine the effects and impacts that the project could generate when implemented. Results of this phase should guide the technological, economic, financial, social and environmental viability of the project. During this phase, the following elements of competence are specifically addressed: resources, cost and finance, business, safety, environment and ethics. The Final phase is *project documentation* (5), where deliverables and final reports are integrated. Synthesis capability is critical for knowing how to communicate properly to the team (teachers, external stakeholders and colleagues) the relevant information, and come up with an opinion on the project.

During this learning process, the content of the units are approached with greater flexibility, and an enriching exchange of opinion is encouraged. Some sessions are introduced with cooperative learning activities [22], using the analogical or comparative method, which aims to increase interdependence among the groups, to establish comparisons of project situations, and to come to new conclusions. For example, occasionally, students analyse the differences in a way to deal with the phases and partial results of the project. In postgraduate level (Master program) some activities are posed with the case study method using an inductive approach.

[1] From the last academic years (2005–06 to 2009–10), 137 students from 29 different countries and from very different educational backgrounds have taken part in the Master EM.

Real situations are presented by the teaching staff, debates are held and exercises related to different phases of the methodology of project formulation and evaluations are given. These sessions, in which students must observe and analyse facts, help students to link theory with reality. Finally, for project presentations, an environment is created to promote free expression of the student's original ideas and thus foster creativity. Table 2 reflects the type of teaching activities and his weight (undergraduate and postgraduate), which primes the collective type and those that are supported by new technologies.

Teaching is supported on information technology in the form of a web platform-GATE. Online teaching support is simply an element to improve communication between students and professors, without activities of self-assessment. The good results of the teaching and learning strategy led to the introduction of a new link with the client: an award for the best projects or viability studies for the community of Madrid presented by students as Final Projects. A joint committee formed by representatives of the client and of the GIE-Project award the prize of a monetary sum to the best project. This way, as in the professional world, team competitiveness is promoted. Also, many of the platforms for supporting teaching and learning activities with information technology, which began at that time in the UPM, were in an experimental stage and the teachers in a period of training.

Two important events happen during the last period: firstly, in the year 2005, the educational program was approved by the EU as Erasmus Mundus Master of Science; on the other hand, *Tuning Initiative* of UPM started as an original web project space to promote professional skills. These *Tuning Initiative* outcomes as well as its tools are presented in a range of Tuning ''virtual classroom'' and on-line publications, which institutions, their students and academics are invited to test and use in their own setting. One of these virtual classrooms, called ''Project Management Competencies'', aims to facilitate the promotion of the Certification of professional Project management Competence (PM) in Engineering Higher Education. This Personnel certification has become an important element, verifying the competence of an increasingly mobile and global workforce, underscoring the value of industry-recognized credentials that can be carried out across national borders. In response to this growing need, a new and improved ISO/IEC International Standard aims to harmonize the various procedures used around the world for certifying the competence of personnel in different occupations or professions (ISO/IEC, 2012). This important milestone reinforces our teaching and learning strategy. Thus, the standard of the International Project Management Association (IPMA) was adopted. More than forty national professional associations from the entire world integrate this organization. In this sense, adoption of this standard enabled the initiation of specialized training of future professionals with more opportunities in the outside world.

The IPMA certification schemes and systems of certifying bodies—as defined in the UNE-EN ISO/IEC 17024—are an incentive for project managers and members of project management teams (i.e. the project management personnel) to expand and improve their technical, behavioural and contextual Project Management (PM) competences, continuing their education and experience in PM, improving the quality of PM, and last but not least, successfully achieving the project, programme and portfolio objectives [34]. The certification system is organised around four levels, and combines all of the elements of PM competences distributed in three dimensions: technical, behavioural, and contextual competences [19], containing fundamental terms, tasks, practices, skills, functions, management processes, methods, techniques and tools that are commonly used in project management.

The teaching & assessment strategy tested up to now, following the PBL approach, has met this

Table 2. Types of teaching activities in the project-based learning methodology

Teaching activities in the learning strategy	Undergraduate*	Postgraduate**
Lectures (supported by presentations to present concepts)	20	15
Final group work outside the classroom for project formulation	28	23
Participative workshops for the course project (PBL)	20	25
Cooperative learning activities for group interdependence	10	10
Learning activities based on problems (problem-solving)	6	6
Activities pertinent to the case study method	2	15
Support from information technology (moodle platform)	15	15
Group tutoring for course projects	18	10
On-line tutoring for course projects	10	10
Assessment: self-assessment, ongoing evaluation	10	10

* Project oriented topics, for the graduation (6 ECTs).
** Specific teaching activities in Project Management (6 ECTs), Postgraduate Master's Level Courses: Master of Science (MSc) ''Planning and Management of Sustainable Rural Development'' Erasmus Mundus Masters, Agris Mundus (60 ECTs).

standard perfectly: the students conduct a pre-professional experience connecting elements of technical and contextual competences in the sphere of rural development projects with the needs of the productive sector and real problems of the countryside. From an educational point of view, elements of personal competences are also developed: teamwork, communication, leadership, commitment and motivation, openness, creativity, outcome orientation, efficiency, values and the capacity for adaptation and innovation in problem solving [23]. The GATE—Tele-education Office of the Polytechnic University of Madrid—was important in providing support services for activities on educational innovation in general. During the implementation of the Teaching and Learning strategy, a number of structural problems were encountered, mainly adjusting annual course credits (ECTS), teaching hours to four-month sessions, lack of competence assessment and lack of suitable classrooms for cooperative learning activities and group interdependence.

3.4 Competencies assessment

In order to unify the criteria according to the IPMA competence assessment, and in order to indicate the level of opportunities for improving skills; the interdisciplinary teaching team uses the same scale for each skill element covered by the strategic learning planning. Table 3 shows the scale proposed by AEIPRO for indicating the learning objective levels, integrating the technical and contextual competences. Using this same scale will help comparing educational programmes and will allow choosing the most suited one in order to obtain the IPMA certification.

The objective of assessing competences is to obtain evidence of a performance or learning in order to help valuing judgments and decisions making about the performance of a person, whether in a job, a project or academic activity. Through these years, different tools and methods for competence assessment have been identified, with their respective activities and supporting elements that have been progressively incorporated. These tools and techniques used for competence assessment will depend on the competences to be measured, the level up to which the competence was developed and should be related to the question of *what* and *how* much evidence is enough to assess what needs to be evaluated. We must consider that there are no instruments that alone can provide all the necessary information to make a judgment of value whether a person is competent or not, instead we assume that there are many tools and techniques that can be used [36]. This way, we can integrate and combine different ways of collecting evidence on whether the competence was developed or acquired.

Consequently, our PBL strategy includes the following assessment activities within the course: (i) ongoing evaluation of skills, knowledge and performance assessment (Multiple Choice Test, Rubrics, Portfolio Assessment, Checklist); (ii) Behavioural assessment between teammates and supervising teachers (360-degree feedback and Peer Assessment), a tool that provides each student the opportunity to receive performance feedback from his or her supervisor and four to eight staff members (through these behaviour assessment each student gives the top 5 strengths and 5 areas to improve).

For competence assessment two instruments are used: Self-assessment of their knowledge and experience on the competence base of Project Management IPMA-AEIPRO (questionnaire Q1): Skill questionnaire and attitude Scales (questionnaire

Table 3

Assessment of technical and contextual Skills

Level	Knowledge of methods	Practical application
1	Is aware of the name of one method. Is able to describe a few steps of the application of the process.	Recognises, with hesitation, the method when they see it. Can remember having participated when it was applied in simple projects.
2	Understands the concept and use of a variant of the method. Is aware of the majority of the steps involved.	Absolutely recognises the method. Is able to superficially analyse situations in simple projects and individually apply the appropriate method.
3	Understands several variants of the methods. Is aware of the process for applying the most important methods. Is aware of the simple criteria for choosing between the methods to use.	Can analyse simple situations and is able to select which method to use and describe most of the consequences of its use. Can organise its application, involving others.
4	Solid understanding of various variants of the methods. Is aware of the steps involved in applying the methods. Is aware of some criteria for the successful use of each method and can describe the most important consequences of its use.	Analyses complex situations in projects and is thus able to select methods and variants. Can describe how the application of the methods will influence the project and solve problems. Can organise the application, involving several areas in complex projects.

Q2). Both instruments used a Likert scale [37], commonly used in social sciences to assess perceptions and qualitative aspects and whose main purpose is to stagger individuals [36]. Thus the main objective of staggering is to determine the value of a variable as accurately as possible, seeking thereby its usefulness and therefore its quality [6].These two instruments were applied during the last period (since the year 2010–2013) to a total of 209 students (142 undergraduate students enrolled in the Projects Lecture of Engineering and 67 Postgraduate Master's students enrolled in ''Project Management'' Erasmus Mundus). The self-assessment tools were made through Moodle (Virtual Platform of the UPM).

Questionnaire 1 (self-assessment skills) was implemented as a self-assessment survey at the beginning and end of the academic period. This assessment instrument was designed based on the tool used by IPMA [20] for the evaluation and certification of competences on Project Management [38], which includes 92 items—46 on knowledge of competence and 46 on experience—covering three areas of competence: elements 20 technical, 11 contextual and 15 of professional behavioural, according to the baseline from the Project Management Competence from IPMA (NCB-IPMA AEIPRO). Questionnaire 2 was applied at the end of the course and was originally designed with 61 questions related to student participation (PBL teamwork) in the course of the project and the skills development associated to teamwork. This questionnaire was developed based on different variables used in previous studies [36, 39–41].

In order to validate the psychometric properties of these instruments, an *analysis of the reliability* were implemented, using internal consistency coefficient Cronbach's Alpha. Nunnally [42] proposes a minimum of 0.700 and some authors claim that reliabilities of less than 0.600 are not suitable for making decisions about individuals and it is contested because of the description of a group or research in general. We remove some items, which thus allow us to improve the reliability. Tables 4 and 5 show the final internal Consistency Results of the Questionnaires with a Cronbach alpha reliability.

On the other hand, an *analysis of construct validity* was carried out estimating through factor analysis [43]. Because the self-assessment questionnaire (Q1) designed by IPMA [20] is being used as a reference tool in the evaluation and certification of skills in Project Management, there was no need to validate it. Finally, the educational program has an evaluation system in order for participants to evaluate the Master course, at each edition, with regards to the content, organization and development of the same. Similarly, the European Commission has evaluated the program, as a case study within the ex-post Erasmus Mundus evaluation [44]. The proposals and conclusions of this assessment process, allow learning to be established in order to improve the integration of skills and training in future editions. This Master's assessment is composed by two main aspects: a continuous and individual evaluation process, and a final participative evaluation session (empowerment evaluation). This final participative evaluation is carried out with the objective of completing the continuous evaluation process, and contrasting by collectively discussing the individual evaluations. It consists of two sessions, an initial session with the students and a second session with the Academic Committee and management team.

Table 4. Self-assessment Project Management (knowledge and experience) (Q1)

Q1 Self Assessment	Items	Cronbach Alpha
Knowledge	46	0.958
Experience	46	0.945

Table 5. Internal Consistency Results (Q2)

Q2 Competence	Items	Cronbach Alpha
Creativity and Innovation	8	0.765
Leadership	15	0.848
Negotiation	9	0.712
Teamwork	19	0.864
Total	50	0.938

3.5 Review (learning)

Results show that students, through the project-based learning methodology, improve knowledge and professional skills in three project management areas (technical, contextual and behavioural). Table 6 shows the overall results (self-assessment survey at the beginning and end of the academic period) obtained in the three areas of skills.

In relation to competences it appears that at

Table 6. Overall results of the evaluation of knowledge (Q1)

Skills	Initial	Final*	Variation
Improvement in technical skills	40%	83%	43%
Improvement in behavioural skills	77%	92%	15%
Improvement in contextual skills	25%	74%	49%

* At the end of the Erasmus Mundus Master academic period.

Table 7. Results of the competence development (% of total students)

Level	Teamwork	Creativity	Negotiation	Leadership	Overall
4	48	40	29	35	40
3	44	47	50	46	46
2	4	6	10	9	7
1	4	7	11	10	7

Strongly improvement (4), improvement, (3) slightly improved, (2) no improvement (1).

group level (86% of students) achieved high competence development. This development means that most of the population, after participating in the teaching and learning PBL activities developed other skills and behaviours. These skills, related to teamwork, obtained high values: creativity (4.3), leadership (4.1) and negotiation (4.0). It is clear that the strong relation of PBL teamwork success, with the development of other skills. After the application of the questionnaire (Q2) at the end of the academic period, the results show that the students developed a set of skills associated with teamwork (92%), creativity (87%), leadership (81%) and negotiation (79%) within project activities.

Some of the most successful factors of the model that stand out are the following: the link between training and professional certification; the evaluation of technical, contextual and behavioural professional skills, using PBL techniques [32]; the students' exposure to real problems; cooperative learning; and the mobility and integration of teaching and research [44]. On the other hand relationships between IPMA and the UPM model for the certification of students are encouraged through Project Management Classes: Tuning Initiative of UPM (*Puesta a Punto*) that aims to offer comprehensive training to students as future project managers in the international context. In this ''Tuning Initiative'' the steps for international certification of students in the IPMA system are set: a complementary postgraduate seminar and Certification IPMA-AEIPRO. This international ''Project Management Competences'' certification, aims to facilitate the promotion of professional project management skills in Engineering Higher Education.

4. Discussions

The experience that has been described has evolved over the years from a simple Project Based Learning (PBL) methodology in isolated subjects [23], to a wider strategy of a Masters programme of 60 ECTS. Project Based Learning has secured its place as the most suitable educational tool for developing skills and linking learning activities to the professional environment of academic programs. The learning techniques are based on cooperation [31], active participation and interaction [33], offering several possibilities for developing technical, contextual and behavioural skills. The analysis and learning of this model allows us to extract some features that made the methodological process suitable for promoting professional project management skills in Engineering Higher Education; the evaluation of this process provides a series of future issues and general findings:

A methodological change has begun at the UPM, within the framework of the European Higher Education Area, and based on the standards of the International Project Management Association (IPMA). In these international tendencies, the professional project management skills is seen as a key element [13] and finds a wide range of employment opportunities [45] in all industries, especially in engineering consulting, construction and energy firms, as well as in the public sector [14].

As a key element of the change, an interdisciplinary team teaching (involving faculty from different technical specialties Agricultural Engineering, Forest Engineering, Civil Engineering, Industrial Engineering, Technical Architecture, Public Works School) has been created. With IPMA certified professors, who speak a ''common language'', promote collaboration between Schools at the UPM, opening new possibilities for communication, educational innovation and interdisciplinary cooperation. We can highlight the qualitative leap that accompanies the change from methodologies based on the individual work of the professor to those based on more complex structures. In this experience, the relationship between Educational Innovation Groups and Researchers Groups integrates teaching and applied research and develops an entire educational strategy for undergraduate (project courses) and postgraduate programs (PhD Thesis and Master Thesis Project).

Competences involve a wide range of knowledge, procedures and attitudes that are combined and integrated and that must be known individual in order to become a professional [3]. It also incorporates ethics, values and practice as elements in the domain, which will permit the individual acting effectively in professional situations [5]. The learning and evaluation model has been designed and implemented by the international stander's ICB [8], incorporating Project Based Learning (PBL) as well

as focusing on technical, contextual and behavioural skills for project management. The model is gradually applied by the interdisciplinary team teaching, modules at undergraduate and postgraduate level, with students involved in the Masters Programmes. This learning and evaluation model requires that both teachers and students assume a more active role, greater shared commitment, and in the particular case of the students, greater responsibility for their own learning. Throughout the different levels and different phases, the scientific basis of project-based learning is maintained to generate learning processes. In this PBL process the students are not passive recipients of knowledge, but are immersed in a pre-professional experience thanks to the link between the university and the external agents, defining projects with real content, which require students to integrate the knowledge they have already gained from other courses with new knowledge attained by developing the project.

On the basis of this PBL model and considering that technical competences are not enough in the actual world [9], personal competences (soft skills) are also developed. Professionalism, respect, awareness, ethics, environmental sustainability, decision-making in extensive and participatory processes, proper management of scarce resources, and so on is integral. Students learn to work in teams, potentiating their personality and taking them closer to reality. The methodology arouses a spirit of investigation and innovation, creating new knowledge, productive thought, and motivation to learn and solve problems. According to CDIO and IPMA, the list of professional competences is divided in two groups: a group of ''hard'' skills (technical competences for project management) and a second group called ''contextual and behavioural skills'' for project management [1]. This allows to use IPMA codification in the competence definition of an engineering student and be confident that will the ABET certification will be exceeded. Students attested to an improvement in their own project management skills: technical (with an improvement of 43%), behavioural skills (an improvement of 15%) and especially in contextual skills (with an improvement of 49%).

The operational instrument for the realization of this Teaching and Learning strategy has been cooperation agreements between the university and the external agents, setting the professional process as the ideal environment for engineering education and promotes the competence learning as a cooperative context. The results show the potential of external agents—clients—in improving university teaching models, opening up new spaces for educational innovation with cooperative learning models based on projects. The ''common language'' (IPMA elements) facilitated collaboration between different UPM Schools and opened new possibilities for communication, educational innovation, and cooperation with external and international agents (industries, engineering consulting, as well as in the administration and public sector). The necessary competences approach advocated by EHEA and the international professional Project Management standards (IPMA) has been used as an opportunity to establish a new connection with the professional world by adopting the professional standard recognized internationally as our referent. The fundamentals of the project management competences defined by the International Project Management Association (IPMA) are adapted to facilitate training in technical, behavioural and contextual competences.

On the other hand, training has been linked with the certification of professional skills, helping to prepare graduates at UPM for the Certification of Professional skills (IPMA). The educational program should seek to link vocational training with professional certification and assessment of competences. The certification of people means ensuring that the professional meet certification requirements of the governing organization [19]. This connection also permits linking university education with a system of professional certification, which opens up better future opportunities for our graduates. The UPM has carried out certification activities according to the IPMA 4LC model and *Tuning Initiative* of UPM started as an original project to promote professional skills and the Certification of professional Project management Competence (PM) in Engineering Higher Education. Professors from the Educational innovation Group (GIE-Project) have been certified in order to gain an in depth understanding of the model and its evaluating mechanisms.

5. Conclusions

Technical competences are not sufficient for today's world, and the technical education of the future should be more integrative, supporting a framework of appropriate generic competences and curricula that develop competences. Moreover, in an increasingly global economy, engineering professionals need guidance in order for them to understand the basic principles of project management.

During the past recent years, academia and society in general have revealed that the main factors for professional success, do not come from exclusively technical knowledge, instead; success comes from a competence dimension, and more specifically from behavioral and contextual competencies. Certification processes that serve a pool of

professions has also arisen to ensure that society's need of guaranteeing that people have the right skills for a particular professional profile is met. It is therefore logical to know and to integrate these international standards as a necessary step for adequate engineer training.

From the review of these trends and professional certification systems, the training of new engineers should incorporate skills from the three interrelated dimensions. Firstly the traditional technical dimension of competencies, which provides knowledge in order for engineers to be able to design technologies, products and services that meet the demands and problems of society. Moreover, the contextual dimension ensures engineers are able to relate to a changing and multicultural context: the political-administrative sphere, the international framework, and the legal and financial factors. Finally, the ethical and social dimension of competencies defines and establishes the "fundamental values"—define acceptable behavior and develop character—as necessary elements for future professionals to overcome moral conflicts and influence the enhancement of society.

Among all the professional competence approaches, the holistic approach defines professional competence as the result of a mixture of personal underlying issues that allow the existence of cognitive, functional, behavioral and ethical-value competences that determine professional skills. IPMA has defined a group of competence elements for project management, with a holistic approach, that makes it suitable to serve as basis in determining the competence codification required by a superior education graduate. The current proposal—Project based learning (PBL) strategy with the IPMA approach—from the authors, is based on the certainty that higher education's role is educating students to be modern engineers.

Versus the traditional technocratic vision of an engineer, that tended to lack social issues considerations, new models are emerging for Engineering Higher Education, that aim to incorporate the social dynamics of human beings and their social relations. Teachers and education authorities have the challenge of designing curricular schedules that allow the students to enjoy autonomous learning and integral development, from the three dimensions of competencies that will help them thrive successfully into today's professional world.

References

1. M. Palma, I. De los Rios and E. Miñán, Generic competences in engineering field: a comparative study between Latin America and European Union, *Procedia Social and Behavioral Sciences*, **15**, 2011, pp. 576–585.
2. Commission of the European Communities, Conference of Berlin. Berlin, September 2003, Communication, European Commission, Ministers responsible for Higher Education.
3. K. S. Pister, A context for change in Engineering, *Journal of Engineering Education*, **82**(2), 1993, pp. 66–69.
4. N. Augustine and C. Vest. Engineering Education for a Changing World, Joint Project by the Engineering Deans Council and the Corporate Roundtable of the American Society for Engineering Education, ASEE, 1994.
5. E. F. Crawley, J. Malmqvist, S. Östlund and D. Brodeur. Rethinking engineering education: the CDIO approach. Springer Science. 2007.
6. D. Guerrero and I. De los Rios-Carmenado, International models of professional competence. *DYNA Ingeniería e Industria*, **88-3**, 2013, pp. 266–270.
7. B. Figueroa-Rodriguez and I. De los Ríos-Carmenado. Approaches for the Competences Assessment in Higher Education. *Proceedings ICEEM International Conference on Economic, Education and Management*, International Association of Education Science and Engineering, USA, **1**, 2012, pp. 337–342.
8. IPMA, International Project Management Association. National Competence Baseline.V3.0, 2009. Asociación Española de Ingeniería de Proyectos. Valencia. AEIPRO.
9. F. Maffioli and A. Giuliano. Tuning engineering education into the European higher education orchestra. *European Journal of the Engineering Education*, 2003, pp. 251–273
10. L. Barroso and J. Morgan, Jim. Project Enhanced Learning: addressing ABET outcomes and linking the curriculum. *Journal of professional issues in Engineering Education and Practice*, ASCE, Jan 2009, pp11–20.
11. R. M. Felderand R. Brent, Designing and Teaching Courses to Satisfy the ABET Engineering Criteria, *Journal of the Engineering Education*, **92**(1), 2003, pp. 7–25.
12. ABET, Engineering Accreditation Commission, http, Accessed June 2012.
13. M. Winter, C. Smith, P. Morris and S. Cicmil, Directions for future research in project management: The main findings of a UK government-funded research network, *International Journal of Project Management*, **24**, 2006, pp. 638–649.
14. I. Pant and B. Baroudi, Project management education: The human skills imperative, *International Journal of Project Management*, 2008, **26**, pp. 124–128.
15. W. Kelly, Certification and Accreditation in Civil Engineering, *Journal of Professional Issues in Engineering Education and Practice*, **133**(3), 2007, pp. 181–187.
16. P. Morris, Exploring the role of formal bodies of knowledge in defining a profession: the case of project management, *International Journal of Project Management*, **24**, 2006, pp. 710–21.
17. D. Hodgson, Disciplining the professional: the case of project management, *J. Manage Stud*, **39**(6), 2002, pp. 803–21.
18. A. Cazorla, I. De los Rios-Carmenado and M. Salvo, Working With People (WWP) in rural development projects: A proposal from social learning, *Cuadernos de Desarrollo Rural*, **10**(70), 2013, pp. 131–157.
19. ISO/IEC:17024. *Conformity assessment: General requirements for bodies operating certification of persons.* Switzerland: International Organization for Standardization. 2013.
20. IPMA, International Project Management Association. IPMA Certification Yearbook, Editors: Werner Schmehr, Hans Knoepfel. http://www.ipma.ch/certification 2012.
21. P. Chinnowsky, H. Brown, A. Szajnman and A. Realph. Developing Knowledge Landscapes through Project-Based Learning, *Journal of Professional Issues in Engineering Education and Practice*, **132**(2), 2006, pp. 118–125.
22. P. A. Johnson, Project-Based, cooperative learning in the engineering classroom, *Journal of Professional Issues in Engineering Education and Practice*, **125**(1), 1999, pp. 8–11.
23. I. De los Ríos-Carmenado, A. Cazorla, J. M. Díaz-Puente and J. L. Yagüe, Project-based learning in engineering higher education: two decades of teaching competences in real environments, *Procedia–Social and Behavioral Sciences*, **2**(2), 2010, pp. 1368–1378.
24. I. De los Ríos, A. Ros, I. Ortiz, A. Fernández, M. Del Río and A. Romera, Cooperative model for learning and assessment

of behavioural competences in project management according to IPMA-NCB model, *Selected Proceedings 13th International Congress on Project Engineering*, International Project Management Association (IPMA), 2010, pp. 134–146.
25. I. De los Ríos-Carmenado, I. Ortiz and J. M. Díaz-Puente. Project management teaching in engineering higher education: A new perspective for developing competencies, *Selected Proceedings 12th International Congress on Project Engineering*, AEIPRO. International Project Management Association, 2009, pp. 418–427.
26. M. Q. Patton, *Utilization-Focused Evaluation: The New Century Text*, 3rd ed. Thousand Oaks, CA: Sage. 1997.
27. I. Nikolaou, A. Gouras, M. Vakola and D. Bourantis, Selecting change agents: exploring traits and skills in a simulated environment, *Journal of Change Management*, **7** (3/4), 2007, pp. 291–313.
28. A. Nieminen and M. Lehtonen, Organisational control in programme teams: an empirical study in change programme context, *International Journal of Project Management*, **26**(1), 2008, pp. 63–72.
29. S. Pellegrinelli, Programme management: organising project-based change, *International Journal of Project Management*, **15**(3), 1997, pp. 141–149.
30. I. De los Ríos-Carmenado, J. M. Díaz-Puente and J. L. Yagüe, The integration of project competences within the post-graduate programme: a case study of the International Masters in Rural Development Agris Mundus, *Procedia–Social and Behavioral Sciences*, **15**, 2011, pp. 96–110.
31. P. Johnson, Project-Based, cooperative learning in the engineering classroom, *Journal of Professional Issues in Engineering Education and Practice*, **125**(1), 1999, pp. 8–11.
32. K. R. Bartkus, Skills and Cooperative Education: A conceptual Framework, *Journal of Cooperative Education*, **36**(1), 2001, pp. 17–24.
33. R. Hackett, G. Martin and D. Rosselli, Factors Related to Performance Ratings of Engineering Students in Cooperative Education Placements, *Journal of Engineering Education*, **87**(4), 1998, pp. 445–458.
34. J. Martínez-Almela and I. De los Ríos-Carmenado, Training Project Management complexity in Postgraduate and continuing education programs, *Organization, Technology and Management in Construction: An International Journal*, **3**, 2011, pp. 317–332.
35. B. Robinson and C. Schaible, Collaborative teaching: Reaping the benefits, *College Teaching*, **43**, 1995, pp. 57–60.
36. D. Kember and D. Leung, Development of a questionnaire for assessing students' perceptions of the teaching and learning environment and its use in quality assurance, *Learning Environments Research*, **12**, 2009, pp. 15–29.
37. R. Likert. A technique for the measurement of attitudes, *Archive of Psychology*, **140**, 1932, pp. 1–55.
38. J. L. Cano, I. Lidón and R. Rebollar, Learning Project Management through working for real clients, *International Journal of Engineering Education*, **24**(6), 2005, pp. 1199–1209.
39. J. Ainley, The Postgraduate Research Experience Questionnaire, *Australian Council for Educational Research*, 1999.
40. P. Ginns and R. Ellis, Quality in blended learning: exploring the relationships between on-line and face-to-face teaching and learning, *Internet and Higher Education*, **10**, 2007, pp. 53–64.
41. R. Muller and J. R. Turner, Matching the project manager's leadership style to project type, *International Journal of Project Management*, **25**(1), 2007, pp. 21–32.
42. J. C. Nunnally and I. H. Bernstein, *Psychometric Theory*, 3rd. Ed. New York: McGraw-Hill, 1994, pp. 34–38.
43. G. A. Morgan, J. A. Gliner and R. J. Harmon, Measurement Validity, *Journal of the American Academy of Child and Adolescents Psychiatry*, **40**, 2001, pp. 729–731.
44. ECOTEC, Ex-post evaluation of Erasmus Mundus. Case Studies. European Commission, 2009, pp. 125–132.
45. I. De los Ríos-Carmenado, J. M. Díaz-Puente and J. Martínez-Almela, The Effect That Project Management Certification has on Employability: Agents' Perceptions from Spain, *Communications in Computer and Information Science*, **208**, 2011, pp. 35–47.

Ignacio De Los Rios, Ph D Agricultural Engineering Associate Professor Deputy Director of School of Agricultural Engineering (UPM), Internship External Coordinator. Certified Project Manager (International Project Management, IPMA). Coordinator Joint Doctorate Erasmus Mundus Programme of the European Union. Team Leader of Educational Innovation Group GIE-Project, member of GESPLAN Research Group (Planning and Management of Sustainable Rural-Local Development). He is a member of the Advisory Council of Educative Innovation UPM. Quality Manager, Spanish Certification body accredited for person's certification in project management (OCDP). Assessor IPMA. Director of the Postgraduate course Certification in Project Management. During the last 20 years he cooperated with Governments, Universities and Enterprises in the framework of Engineering Projects, Planning and Rural Development in Europe and Latin America. He has participated on Planning and Rural Development in Latin America and other underdeveloped countries. Wide experience in project management, networking for Rural Development, planning and evaluation for development. He has participated in several projects at International in the framework of the *Consultative Group on International Agricultural Research* (CGIAR) and in the "European Initiative for Agricultural Research for Development" (EIARD). He has coordinated support for international research organizations, National Agricultural Research Organizations in developing countries and Head of Innovation Unit for Sustainable Rural Development (2002–2006). Director of 16 PhD. National Price for his PhD Doctoral Thesis (1998) and he won the Educational Innovation Award in the UPM (2005). He has participated in 56 National and International Congress and Scientifics Meetings. He is the author of more than 80 published (37 articles in scientific journals, 9 books and 38 book-chapters) and has gained recognition for twelve years of international-quality research (complement 2 of research merits), from the national committee for the assessment of the research action (CNEAI).

Fernando Rodriguez Lopez, PhD Civil Engineer. Civil Engineer and PhD in Civil Engineering of Technical University by Madrid. Associate Professor. Currently Coordinator (Academic Head) of the thesis, School of Civil Engineers (UPM), Department of Civil Engineering (Construction).Professor of Process Assessment, Professor of Teaching Unit Project and Thesis, Acting Professor of Physics Teaching Unit, all in the School of Civil Engineering (UPM). Member of the Board of School of Engineering School of Roads, Channels and Ports of the Technical University of Madrid since 1991 by choice, and since 2004 by appointment of the Director of the School. Member of World Council of Civil Engineers (WCCE), with Vice-President of Sustainable Certification Subcommittee, Vice President of Chair of the Subcommittee on Sustainable Certification—Chairman of the Subcommittee on Insurance and Guarantees of Civil Engineering, Chair of the Subcommittee on Insurance System and Warranties of Civil Engineering, and Vice-Chairman of Construction

Committee—Vice President of the Standing Committee on Construction of the World Council of Civil Engineers—World Council of Civil Engineers (WCCE). Director for the Sector 5 ''Freelance and Consulting Engineers'' General Council of COICCP. Vice Chairman of the Advisory Committee on Visa and professional activity COICCP governing board. Board Member General Council of the General Council COICCP Mesa. Member of the professional advisory and consulting firms COICCP governing board. He has received several awards: in 2008 by the World Council of Civil Engineering (WCCE) contributions and research achievements; Best department of the Polytechnic University of Madrid by the General Foundation of the Polytechnic University of Madrid; Best Project for building better quality housing in the Community of Madrid by the Housing Institute of Madrid-IVIMA; Award for best research work of concrete between students of technical colleges by Hales. National Training Plan Scholarship Research Staff by the Directorate General for Science Policy; Grant Implementation and experimental PhD by the Technical Institute of Materials and Constructions (INTEMAC).

Cristina Pérez García, PhD Organic Chemistry from the Complutense University. Professor in the School of Forestry Engineering, teaching and research in the Department of Science Applied to Agroforestry Engineering. Secretary-General or Secretaryship of the Technical University of Madrid from April 2007, responsibility for which now continues. She has worked in different fields of organic chemistry, which has developed research focused Chemistry Forestry physical-mechanical characteristics of wood of different species. From 1999 he held the sub address University Extension and Outreach Forestry EUIT. She is member of the Educational Innovation Group GIE-Project and member of GESPLAN Research Group (Planning and Management of Sustainable Rural-Local Development). She is a member of the Advisory Council of Educative Innovation UPM; Member of the Advisory Council of the Association of Fashion Design Madrid, FUNDISMA. She has participated in several Educational Innovation Projects. She has gained recognition for years of international-quality research (complement of research merits) from the national committee for the assessment of the research action (CNEAI).