International Journal of Engineering Education Vol. 34, No. 3, pp. 1038–1048, 2018
Printed in Great Britain
0949-149X/91 $3.00+0.00

Self-Perceived Benefits of Cooperative and Project-Based Learning Strategies in the Acquisition of Project Management Skills*

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This paper summarizes the results of applying cooperative and project-based learning strategies in two different engineering courses in order to explore their benefits in the students' self-perceptions of project management skills. Nine technical skills and four behavioural ones were evaluated during the academic years 2012–13 and 2013–14 in Civil Engineering, and 2014–15 and 2015–16 in Forest Engineering courses (117 students). The first strategy consisted of the preparation of a project plan to solve a customer's request and the second one was the drafting of a Facebook page to promote one specific commercial project. Results from this study show the strong improvement observed in all the skills studied, these self-rating increases were statistically significant in most of them by the end of the courses. Different tests were applied in order to appropriately assess statistical significance depending on self-rating data distribution. This work confirms the benefit of the application of cooperative and project-based learning strategies on self-perceived improvement in the students' project management skills in engineering courses. These findings are of considerable interest to engineering institutions that want to advance in favour of the students' perceptions of competence and they serve to deepen the combined effects of cooperative and project-based learning in higher education.

Keywords: cooperative-based learning; project-based learning; skills; project management

1. Introduction

In general, the problems that future engineers will need to solve are related to improving mankind's quality of life by designing effective solutions to meet social needs [1]. In order to strengthen engineering skills, some of these important challenges have been recently identified: make solar energy economical, provide energy from fusion, advance health informatics, prevent nuclear terror, advance personalized learning or restore and improve urban infrastructure, among others [2]. The National Academy of Engineering report "The Engineer of 2020" concluded that universities and higher education institutions involved in engineers' teaching and training should focus their efforts on producing professionals with: strong analytical skills, practical ingenuity, creativity, good communication skills, business and management knowledge, leadership, high ethical standards, professionalism, dynamism, agility, resilience, flexibility, and the pursuit of lifelong learning. This report also stated that "In 2020, technological innovation will continue its rapid pace; the world will be intensely interconnected; those involved with technology will need to be multidisciplinary; and social, cultural, political, and economic forces will impact technological innovation. Ever-shorter product development cycles through innovation will help drive society's economic growth and remarkable opportunities will arise through new developments in nanotechnology, logistics, biotechnology, and high-performance computing" [3]. According to [4]: innovation is a process to put new ideas into practice, where creativity acts as a vital tool. In this sense, many works emphasize the need to support engineering students in their ability to think creatively [5, 6], even in early years [7]. Thus, the aptitudes and abilities that society currently demands of graduate engineers should constitute a crucial aspect of designing appropriate new higher education strategies. In this sense, Engineering education should be focused on providing knowledge and technical ability, being flexible enough to demonstrate a rapid adaptation to current and changing social contexts [8]. Thereby, the need to develop a model based on competencies in a higher education context such as the European Higher Education Area (EHEA) is a matter of great interest with respect to meeting several challenges for improving the life of citizens [9]. Transversal higher-order competencies, such as critical thinking, analytic reasoning, problem-solving, or the generation of knowledge, and the interaction between substantive and methodological expertise, are widely viewed as being critical in order for individuals to succeed. They are also of rising relevance in this "Information Age", and they

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* Accepted 23 January 2018.

have an important impact in terms of socio-economic development on a large variety of disciplines [10]. Since enterprises currently demand competent professionals instead of simply experienced ones, the EHEA ought to develop the above-mentioned transversal competencies in order to increase the employability of students [11].

Professional competence is defined as being a package of knowledge, attitude, skills and relevant experience, which are required in order to be successful at any job [12]. In this century's information society and in an increasingly global economy, it is not enough to have technical competencies to work professionally as an engineer [13]. In fact, postgraduate engineers with capabilities in skills such as Project Management find more employment opportunities in many sectors such as construction, energy or engineering consulting [14]. Project Management is the discipline which trains students in the organizing and managing of resources in such a way that they do all the work required to complete a project within defined scope, time and cost constraints [15]. Although there are some business schools and national associations in which engineers can be trained in depth in this academic discipline, several efforts have been made for the inclusion of some competencies in Project Management in the EHEA [11, 16, 17].

Due to the benefits of cooperative learning vs. competitive learning in a classroom [18, 19] and because numerous studies propose project-based learning (PBL) [20] as the most suitable means of achieving engineering effective competence-based education [21, 22], an experiment in Project Management training based on PBL in a cooperative framework was carried out at the University of Córdoba (Spain). These new trends integrate the teaching of knowledge, skills and values, generating learning processes in which students are not passive recipients [23]. Projects are assigned to groups of students with the goal of improving the learning of content [24–26] and providing solutions to real problems, where the students learn from their experience in the course [16]. As it is known, humans construct new knowledge on already acquired and experienced content, in which it is possible to get actively involved and interact with others [11, 27]. Finally, it is important to remark that assessment of students' perception has been properly applied in many researching higher education works in order to study crucial issues such as engineering entrepreneurship [28].

This paper covers students' self-perceptions about the effectiveness of PBL and cooperative learning experiences in order to improve fourteen Project Management skills in Higher Education Engineering. These new strategies were applied during two consecutive academic years, in both Civil and Forest Engineering university degrees.

2. Methodology

Two new teaching strategies were assayed in Project Management courses in engineering degrees (Civil and Forest) at Córdoba University (Spain), in order to assess students' improvement in the acquisition of Project Management skills. Both of them were applied during the academic years 2012–13 (27 students) and 2013–14 (24 students) in Civil Engineering, and those of 2014–15 (24 students) and 2015–16 (42 students) in Forest Engineering courses. These courses in Project Management are composed of 6 ECTS (European Credit Transfer System) including conventional classes (theoretical and practical), one technical visit and occasional seminars related to different topics of each degree. The students did not have any previous experience in the management of any project and their average age was 20 (Civil Engineering) and 22 (Forest Engineering), due to the different years in which the Project Management was included as a subject. Only students regularly attending classes took part in this work.

Fourteen standard competences from the International Project Management Association Competence Baseline V3 [12] were selected to be evaluated, including technical and behavioral ones (Table 1).

According to [17], the well-known PBL structure is divided into 4 phases: information, planning, realization and evaluation. In this last step, a final written project report is evaluated as well as its oral presentation from each student group. In order to analyze the evolution of the students' improvement in the competencies summarized in Table 1, a self-assessment is carried out at the beginning and at the end of the course. Following the model proposed by IPMA in NCB v.3.1 [12], the taxonomy of competence is graded along a scale from 0 to 10 for knowledge as well as experience. This is graded for each competence as follows:

- 0 means that a student has no knowledge and/or experience.
- 1 to 3 means that a student has a low level of knowledge and/or experience.
- 4 to 6 means that a student has a medium level of knowledge and/or experience.
- 7 to 9 means that a student has a high level of knowledge and/or experience.
- 10 means that a student has exceptional knowledge and/or experience.

The first strategy consisted of the preparation of a project plan to solve a customer's request. The second issue was the drafting of a Facebook page

Table 1. Fourteen project management skills from [12] assessed in this work

Technical	
1. Project requirements and objectives (1.03)	They are derived from customer needs, which are driven by opportunities and threats. The project objective is to produce the agreed end results.
2. Project organization (1.06)	This element element covers the design and the maintenance of appropriate roles, organisational structures, responsibilities and capabilities for the project.
3. Teamwork (1.07)	The management and leadership of team building, operating in teams and group dynamics.
4. Problem resolution (1.08)	Identifying the problem and its root cause, developing ideas and options for solving the problem and evaluating the ideas and selecting a preferred option.
5. Project structures (1.09)	A key mechanism for creating order within the project. Hierarchical structures serve to ensure nothing is omitted from the project.
6. Scope and deliverables (1.10)	The project scope defines the boundaries of a project. If the boundaries are not properly defined and if additions to and deletions from the project are not properly documented, then the situation tends to get out of control. The deliverables of a successful project are tangible or intangible assets created by the project for the customer.
7. Time and project phases (1.11)	Time covers the structuring, sequencing, duration, estimating and scheduling of activities and/or work packages. A project phase is a discrete time period of the project sequence, which is clearly separate from other periods.
8. Information and documentation (1.17)	Information management includes modelling, gathering, selecting, storing and retrieving project data (formatted, unformatted, graphical, hard copy, electronic copy). A documentation system should specify the kinds of documents needed for the project.
9. Communication (1.18)	Communication covers the effective exchange and understanding of information between parties. Effective communication is vital to the success of projects and it may take many forms: oral, written, text or graphic, static or dynamic, formal or informal, volunteered or requested.
Behavioural	
10. Leadership (2.01)	Leadership involves providing direction and motivating others in their role or task to fulfil the project's objectives. It is a vital competence for a project manager.
11. Self-control (2.03)	Also called self-management, it is a systematic and disciplined approach to cope with daily work, changing requirements and to deal with stressful situations.
12. Assertiveness (2.04)	The ability to state your views persuasively and authoritatively, it is a competence needing to help ensure effective communications with the project team and other interested parties, so that decisions that affect the project are taken with full knowledge of their consequences.
13. Openness (2.06)	It is the ability to make others feel they are welcome to express themselves, so that the project can benefit from their input, suggestions, worries and concerns. Openness is necessary as a means of benefiting from others' knowledge and experience.
14. Creativity (2.07)	Creativity is the ability to think and act in original and imaginative ways. Creative ideas often require the originator to sell them to the project team before they are accepted.

to promote one specific commercial project. Both projects were carried out throughout each course evaluated in each degree. In the first work, the 'problems' to be solved were real-life requests, since they were proposed by real customers to the teachers previously. Thus, this activity simulated the functions of an engineering consulting firm, where students were the consultants and the teachers worked as mentors, helping them to successfully finish their projects. The second one was based on successful teaching experiments using Facebook [29, 30] and following the recommendations of "writing on the (Facebook) wall" in a professional framework reported by [31]. In this case, the main objective was to raise awareness among students of the great possibilities of using social networks that are easily available and can be used effectively. Also, small and medium engineering companies with no presence in the social networks were previously contacted to obtain their consent to the development of this project by the students.

The PBL strategy in both experiments was based on including common elements of cooperative learning [19]: (1) students were divided into small groups of three to six members; (2) groups had an interdependent structure with high individual accountability; (3) the group goals were clearly defined; and (4) group members supported each other's efforts to achieve them. In addition, during all the courses, the experiments were carried out on the following principles: (1) learning obtained from projects was carried out for real customers; (2) support for student team working; and (3) the supervisory role of the teacher as a group mentor.

In addition, in order to find out if the initial and final self-assessment values of each competence

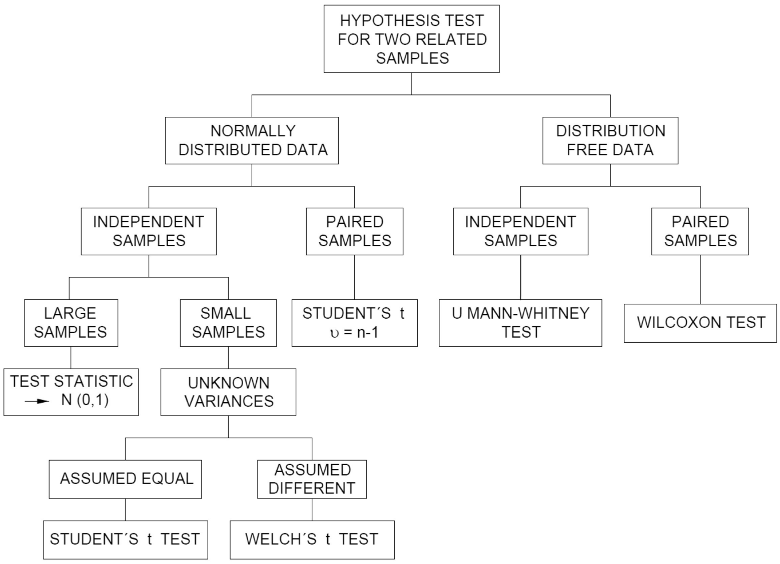

Fig. 1. Schematic diagram of the hypothesis test applied for two related samples (initial and final self-assessments) depending on data distribution.

studied fitted a normal distribution, the Kolmogorov-Smirnov test was carried out. After applying the mentioned test and in order to statistically test the significance of the results obtained, the approach represented in Fig. 1 was followed. As shown, different tests can be applied, depending on data distribution for the two related samples (initial and final assessments).

3. Results and discussion

Figures 2 and 3 highlight the average self-evaluation evolution of the fourteen selected competences (Table 1) in project management from students of Forest and Civil Engineering, respectively. In both figures, results from the two academic years evaluated in each degree are also represented.

In general, with respect to Forest Engineering students in both academic years, an increase can be observed from their initial self-rating average values (dash line) to their final average values (solid line) in all the competencies evaluated (Fig. 2), finding for the year 2014–2015 (in blue) the maximum difference in competences 5 (Project structures) and 14 (Creativity), and the minimum in competences 9 (Communication) and 11 (Self-control). Neverthe-

Fig. 2. Initial and final average values of self-rating in 14 project management skills (Forest Engineering course).

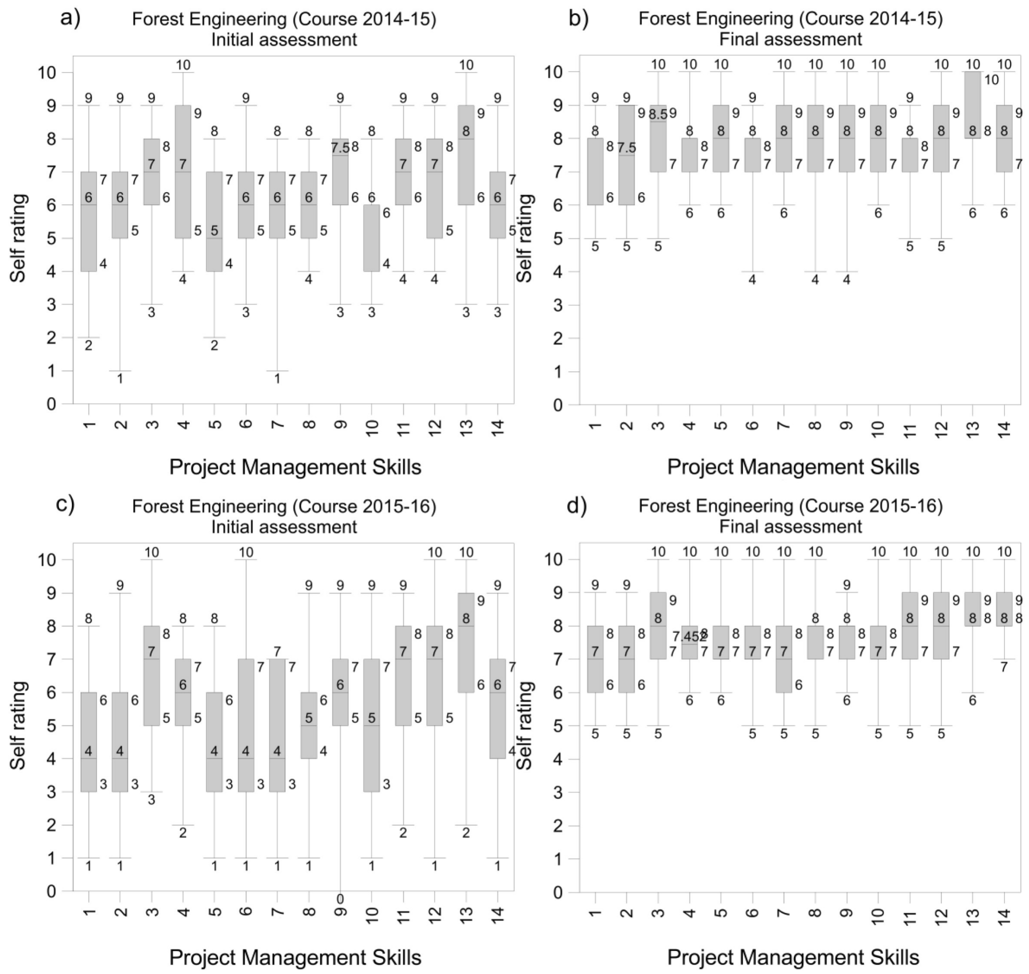

Fig. 3. Box-Whisker chart of self-rating values corresponding to initial (a and c) and final assessments (b and d) of both academic years studied for Forest Engineering.

less, in the 2015–2016 academic year (in orange), the competencies that increased the least were 3 (Teamwork) and 13 (Openness), and those that increased the most were 5 (Project Structures) and 8 (Information and Documentation). It is important to note that the average values of the final competences self-rating were quite similar in both academic years evaluated, but they did not behave in the same way in the initial values, where—with the exception of competence 13—average self-rating values in 2015–2016 were lower than those in 2014–2015. Thus, in general, the improvements in the competencies were greater in 2015–2016.

At the starting of the course, 50% of the Forest Engineering Students in 2014–2015 were believed to have a score of below 6 in competencies 1, 2, 6, 7, 8, 10 and 14 (Fig. 3a), whereas, in the final evaluation, 50% of them scored values of between 7 and 8 values in those competencies (Fig. 3b). In the second year studied, Fig. 3c shows that 50% of the students had an initial range score of between 4 and 5 in competencies 1, 2, 5, 6, 7, 8 and 10, with the scores of the same competencies increasing to 7 and 8 at the end of the course (Fig. 3d). In addition, it can be observed that, in general, the initial self-rating values in 2015–2016 were lower than those detected in 2014–2015, especially in competences 1, 2, 5, 6, 7 and 10, for which 25% of the students had scores ranging from 3 to 1. However, the improvements after applying both strategies in both academic years were outstanding; the self-rating scores of 75% of the students in the two courses increased to 7 and 10 score in competences 3, 4, 5, 6, 8, 9, 10, 11 and 12.

In Figure 4 (Civil Engineering) it can be observed that all the competencies evaluated increased the same as in those of Forest Engineering, although the final and initial average self-rating values in each academic year were quite different. For 2012–2013, the maximum increase detected in the average self-rating values was in competencies 1 (Project requirements and objectives) and 14 (Creativity), competencies 3 (Teamwork) and 12 (Self-confidence) being those that improved less. However, for

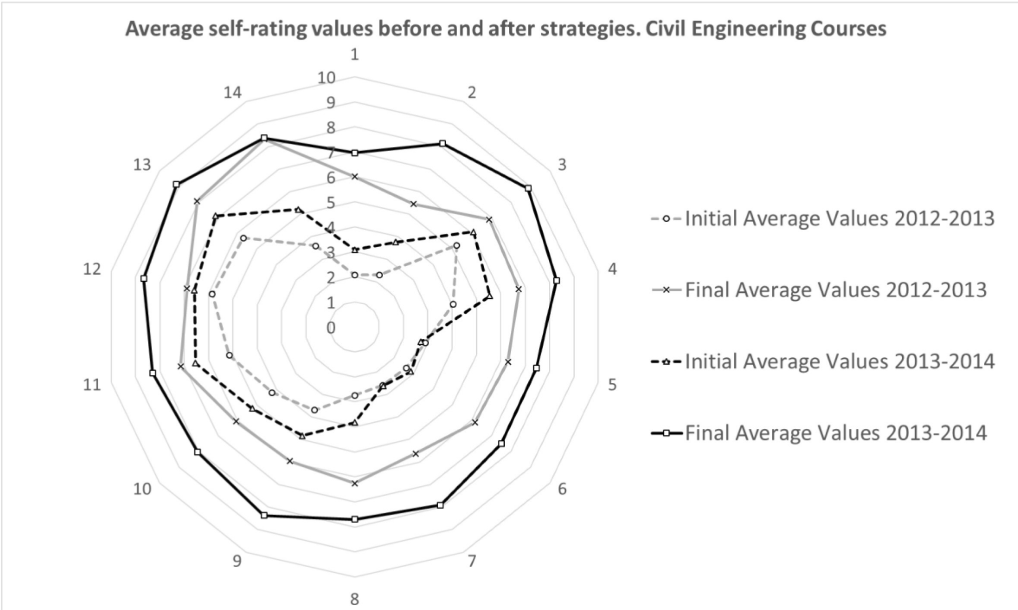

Fig. 4. Initial and final average values of self-rating in 14 project management skills (Civil Engineering course).

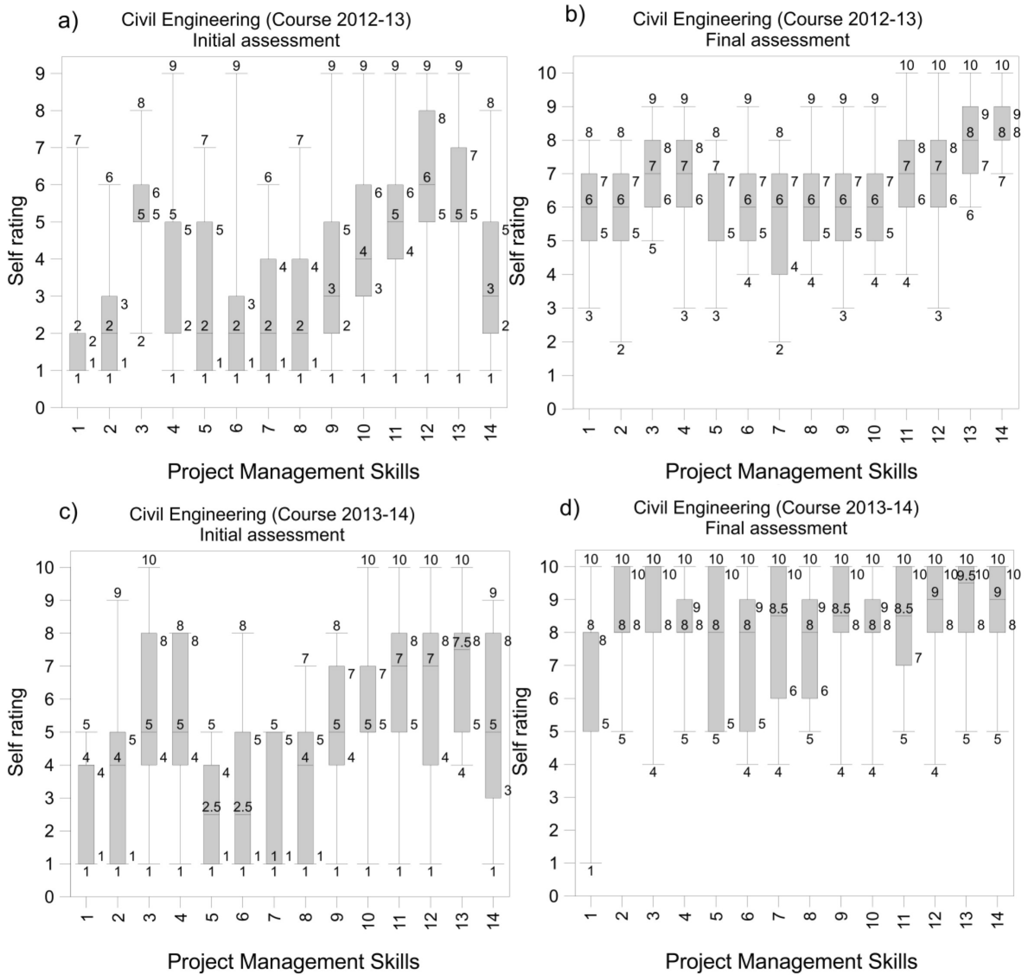

Fig. 5. Box-whisker chart of self-rating values corresponding to initial (a and c) and final assessments (b and d) of both academic years studied for Civil Engineering.

2013–2014, the lowest increase was observed in competencies 12 (Self-confidence) and 13 (Openness), with the greatest improvement being found in competences 5 (Project Structures) and 7 (Time and Project Phases).

Figures 5a and 5c show the initial self-assessment of Civil Engineering students in the academic years of 2012–2013 and 2013–2014, respectively. Probably due to the Project Management course in Civil Engineering degree being taught in second year and in Forest Engineering in the last one, initial self-rating values obtained in both years were, in general, lower than those observed in Forest Engineering, in which students are able to develop some competences during the degree. In this regard, 50% of Civil Engineering students in 2012–2013 considered themselves to have an initial score of 2 or lower in competences 1, 2, 5, 6, 7 and 8 (Fig. 5a). In 2013–2014, 50% of the students had a self-rating value of 5 or lower in all the competences except 11, 12 and 13 (Fig. 5c). After applying the two strategies proposed in this paper, the improvements observed were also relevant. In 2012–2013, the self-rating values of 50% of the students increased, with a

Table 2. Results of Kolmogorov-Smirnov test for Civil Engineering (Course 2012–13)

	Initial self-assessment					Final self-assessment				
	Mean	Median	σ^2	K-S statistic	K-S$_{cr}$ (α = 0.05)	Mean	Median	σ^2	K-S statistic	K-S$_{cr}$ (α = 0.05)
C_1	2.07	2.0	2.76	0.369*	0.255	6.00	6.0	1.92	0.172	0.255
C_2	2.30	2.0	2.14	0.321*		5.44	6.0	2.10	0.168	
C_3	5.22	5.0	2.33	0.220		6.89	7.0	1.56	0.183	
C_4	4.04	5.0	4.50	0.194		6.74	7.0	1.66	0.209	
C_5	2.89	2.0	3.95	0.303*		6.30	7.0	1.99	0.210	
C_6	2.63	2.0	4.17	0.251		6.15	7.0	1.67	0.175	
C_7	2.59	2.0	2.33	0.281*		5.63	6.0	2.47	0.149	
C_8	2.74	2.0	2.81	0.226		6.26	6.0	1.81	0.153	
C_9	3.70	3.0	4.29	0.202		5.96	6.0	2.34	0.143	
C_{10}	4.22	4.0	3.87	0.177		6.07	6.0	1.92	0.183	
C_{11}	5.15	5.0	4.90	0.214		7.15	7.0	1.59	0.213	
C_{12}	5.85	6.0	5.05	0.130		6.89	7.0	3.87	0.152	
C_{13}	5.70	5.0	4.29	0.182		8.07	8.0	1.84	0.182	
C_{14}	3.59	3.0	4.71	0.176		8.33	8.0	0.69	0.248	

* Means that the corresponding samples do not fit a normal distribution.

Table 3. Results of Kolmogorov-Smirnov test for Civil Engineering (Course 2013–14)

	Initial self-assessment					Final self-assessment				
	Mean	Median	σ^2	K-S statistic	K-S$_{cr}$ (α = 0.05)	Mean	Median	σ^2	K-S statistic	K-S$_{cr}$ (α = 0.05)
C_1	3.08	4.0	2.86	0.331*	0.269	6.96	8.0	5.43	0.339*	0.269
C_2	3.75	4.0	6.02	0.210		8.13	8.0	2.20	0.342*	
C_3	6.08	5.0	5.99	0.296*		8.87	10.0	2.98	0.368*	
C_4	5.54	5.0	4.61	0.225		8.29	8.0	1.69	0.328*	
C_5	2.71	2.5	3.17	0.331*		7.46	8.0	4.35	0.256	
C_6	2.87	2.5	4.29	0.317*		7.50	8.0	3.83	0.309*	
C_7	2.63	1.0	3.38	0.353*		7.92	8.5	3.91	0.225	
C_8	3.83	4.0	3.71	0.284*		7.71	8.0	2.82	0.319*	
C_9	4.83	5.0	5.19	0.221		8.38	8.5	2.77	0.286*	
C_{10}	5.25	5.0	6.28	0.294*		8.04	8.0	2.91	0.324*	
C_{11}	6.54	7.0	4.26	0.189		8.29	8.5	3.26	0.203	
C_{12}	6.58	7.0	5.04	0.198		8.67	9.0	2.49	0.253	
C_{13}	7.12	7.5	3.94	0.191		9.12	9.5	1.42	0.269*	
C_{14}	5.21	5.0	6.35	0.199		8.37	9.0	2.77	0.230	

* Means that the corresponding samples do not fit a normal distribution.

Table 4. Results of Kolmogorov-Smirnov test for Forest Engineering (Course 2014–15)

	Initial self-assessment					Final self-assessment				
	Mean	**Median**	σ^2	**K-S statistic**	**K-S$_{cr}$ (α = 0.05)**	**Mean**	**Median**	σ^2	**K-S statistic**	**K-S$_{cr}$ (α = 0.05)**
C_1	5.42	6.0	2.95	0.175	0.255	7.46	8.0	1.48	0.256*	0.255
C_2	5.71	6.0	4.48	0.180		7.46	7.5	1.48	0.172	
C_3	6.96	7.0	2.82	0.191		8.17	8.5	1.54	0.249	
C_4	6.87	7.0	3.07	0.150		7.71	8.0	1.09	0.194	
C_5	5.29	5.0	3.26	0.161		7.79	8.0	1.30	0.214	
C_6	6.21	6.0	2.09	0.182		7.50	8.0	1.57	0.220	
C_7	6.00	6.0	3.30	0.250		8.00	8.0	1.30	0.184	
C_8	6.04	6.0	1.78	0.222		7.71	8.0	1.61	0.205	
C_9	7.25	7.5	2.11	0.197		7.71	8.0	2.22	0.161	
C_{10}	5.54	6.0	1.56	0.227		7.83	8.0	1.01	0.191	
C_{11}	7.13	7.0	2.11	0.216		7.71	8.0	1.09	0.277*	
C_{12}	6.83	7.0	2.49	0.167		8.08	8.0	1.73	0.183	
C_{13}	7.13	8.0	4.55	0.243		8.46	8.0	1.39	0.193	
C_{14}	6.04	6.0	2.82	0.174		8.13	8.0	0.90	0.242	

* Means that the corresponding samples do not fit a normal distribution.

Table 5. Results of Kolmogorov-Smirnov test for Forest Engineering (Course 2015–16)

	Initial self-assessment					Final self-assessment				
	Mean	**Median**	σ^2	**K-S statistic**	**K-S$_{cr}$ (α = 0.05)**	**Mean**	**Median**	σ^2	**K-S statistic**	**K-S$_{cr}$ (α = 0.05)**
C_1	4.21	4.0	4.76	0.134	0.269	6.95	7.0	1.28	0.172	0.269
C_2	4.02	4.0	4.76	0.157		6.81	7.0	1.25	0.184	
C_3	6.36	7.0	3.50	0.167		7.69	8.0	1.59	0.176	
C_4	5.48	5.5	2.50	0.166		7.45	7.5	1.15	0.184	
C_5	3.90	4.0	3.36	0.135		7.31	7.0	1.07	0.222	
C_6	4.64	4.0	5.65	0.154		7.33	7.0	1.32	0.265	
C_7	4.38	4.0	3.90	0.172		7.14	7.0	1.36	0.172	
C_8	4.71	5.0	3.92	0.152		7.69	8.0	1.12	0.245	
C_9	5.90	6.0	4.53	0.161		7.74	8.0	0.96	0.234	
C_{10}	5.0	5.0	4.15	0.146		7.50	7.0	1.06	0.198	
C_{11}	6.19	6.5	3.77	0.162		8.02	8.0	1.31	0.236	
C_{12}	6.35	7.0	5.60	0.131		8.14	8.0	1.27	0.194	
C_{13}	6.97	8.0	4.56	0.280*		8.38	8.0	1.00	0.184	
C_{14}	5.55	6.0	4.99	0.219		8.31	8.0	0.74	0.208	

* Means that the corresponding samples do not fit a normal distribution.

score of 6 or higher in all the competencies (Fig. 5b). The next year, the same percentage of students considered themselves to have a score of 8 or higher in all the competencies except 1 (Fig. 5d).

Results from the Kolmogorov-Smirnov test are reported in Tables 2 and 3 for Civil Engineering in years 2012–2013 and 2013–2014, and Tables 4 and 5 for Forest Engineering courses 2014–2015 and 2015–2015, respectively.

Regarding Civil Engineering students (course 2012–2103), it can be observed that only samples from C1, C2, C5 and C7 initial self-assessments do not fit a normal distribution (Table 2). However, for course 2013–2014 (Table 3), the samples not doing so were C1, C3, C5, C6, C7, C8 and C10 for initial self-assessments, and C1, C2, C3, C4, C6, C8, C9, C10 and C13 for final self-assessments.

With regard to the Forest Engineering courses evaluated, only samples from C1 and C11 final self-assessments did not fit a normal distribution for 2014–2015 academic year (Table 4), and only one sample from C13 initial self-assessments for 2015–2016 course did not (Table 5).

Results from the hypothesis test detailed in Fig. 5

are reported in Table 6 (Forest Engineering) and Table 7 (Civil-Engineering). In all cases, the samples were independent, and the two tailed-tests were carried out for a 5% significance level (alpha = 0.05), in which the null hypothesis is the equal of the means. Regarding Forest Engineering courses, the strong improvements in the acquisition of all the competences are statistically significant for the two academic years analysed, only with the exception of competences 4 (Problem resolution), 9 (Communication) and 11 (Self-control) for 2014–2015. In these cases, no statistically significant differences were detected in the acquisition of the competencies before or after applying the proposed strategies. In this academic year, the student group had probably acquired this kind of skill from other subjects in previous courses. It is important to note that as the Project Management subject is in the final year of the degree, some of the competences analyzed could have been partially acquired before that. However, probably due to the great heterogeneity of the groups in each course, this was not fulfilled for the academic year 2015–2016, when the null hypothesis was rejected in all the competences although the number of students were higher: 24 (2014–2015) and 42 (2015–2016).

In Table 7 it can be observed that all the increases detected in the acquisition of all the competences evaluated were statistically significant for the two academic years studied, with the exception of com-

Table 6. Results from the hypothesis test in Forest Engineering courses

Competences	**2014–2015 Test (α = 0.05)**	**2014–2015 Null hypothesis**	**2015–2016 Test (α = 0.05)**	**2015–2016 Null hypothesis**
C_1	U Mann-W	R	t Student	R
C_2	t Student	R	t Student	R
C_3	t Student	R	t Student	R
C_4	t Student	N.R.	t Student	R
C_5	t Student	R.	t Student	R
C_6	t Student	R	t Student	R
C_7	t Student	R	t Student	R
C_8	t Student	R	t Student	R
C_9	t Student	N.R	t Student	R
C_{10}	t Student	R	t Student	R
C_{11}	U Mann-W	N.R	t Student	R
C_{12}	t Student	R	t Student	R
C_{13}	t Student	R	U Mann-W	R
C_{14}	t Student	R	t Student	R

Table 7. Results from the hypothesis test in Civil Engineering courses

Competences	**2012–2013 Test (α = 0.05)**	**2012–2013 Null hypothesis**	**2013–2014 Test (α = 0.05)**	**2013–2014 Null hypothesis**
C_1	U Mann-W	R	U Mann-W	R
C_2	U Mann-W	R	U Mann-W	R
C_3	t Student	R	U Mann-W	R
C_4	t Student	R	U Mann-W	R
C_5	U Mann-W	R	U Mann-W	R
C_6	t Student	R	U Mann-W	R
C_7	U Mann-W	R	U Mann-W	R
C_8	t Student	R	U Mann-W	R
C_9	t Student	R	U Mann-W	R
C_{10}	t Student	R	U Mann-W	R
C_{11}	t Student	R	t Student	R
C_{12}	t Student	N.R	t Student	R
C_{13}	t Student	R	U Mann-W	R
C_{14}	t Student	R	t Student	R

petence 12 (Self-confidence) for 2012–2013. In these two courses, there as a fairly similar number of students: 27 (2012–2013) and 24 (2013–2014). In this case, because the Project Management subject is taught in the second year, the results are almost those expected, since the students at this level have not yet completed many subjects.

In general, results from the analysis carried out in this work reveals the students' self-perceived benefits of applying the proposed strategies in the acquisition of project management skills in four engineering courses.

4. Conclusions

Nowadays, the engineering profession requires technical and behavioral skills to face the important challenges related to management the new and complex projects that our society demands. Engineering students often perceived lack of relevance of much of their coursework. Therefore, it is necessary the implementation and assessment of new teaching experiences that increase the degree to which students perceive their project management skills.

In order to explore the effectiveness of applying cooperative and project-based learning strategies on students' self-perception to improve project management skills in engineering courses, this work was conducted at Córdoba University (Southern Spain). Self-assessments before and after carrying out the experiment were analyzed in two consecutive academic years in Forest and Civil Engineering degrees, 2014–2015/2015–2016 and 2012–2013/2013–2014, respectively. Nine technical skills and four behavioral ones were evaluated, where each student filled in the corresponding forms graded along a scale of from 0 thru 10 for each skill. Although the Project Management subject is taught in second year in Civil Engineering and in the final year in Forest Engineering, the students did not have any previous experience in the management of any project.

Results from this study reveal the strong improvements detected in all the project management skills evaluated, these increases being statistically significant in most of them for the four courses studied. In some cases, such as in skills 4 (Problem resolution), 9 (Communication), and 11 (Self-control) for the 2014–2015 academic year in Forest Engineering; and skill 12 (Self-confidence) for 2012–2013 in Civil Engineering, no statistically significant differences were detected in the student's self-perception before or after applying the mentioned strategies. On average, skills 5 (Project Structures), 8 (Information and Documentation) and 14 (Creativity) were those increasing the most in the two courses evaluated in the Forest Engineering degree. In the case of Civil Engineering courses, the project management skills with the highest average increases were 1 (Projects requirements and objectives), 5 (Project structures), 7 (Time and Project phases) and 14 (Creativity). In general, these results will have a positive impact on the future work activity of graduate students because of these capabilities are needed to start, to manage the execution of, and to close an engineering project properly, including the crucial elements related to personal attitude.

Due to the high qualifications in terms of knowledge, adaptability and innovation that the present society demands from future engineers, teaching experiences carried out in this work will contribute to enhance their ability to develop with solvency multidisciplinary projects, Thus, the incorporation of this kind of activity in Higher Education will improve the training in general terms of the students, and are valuable strategies which could be included in other engineering courses.

Acknowledgements—The present work was developed under the framework of three Teaching Innovation Projects: 2015-2-5007, 2014-12-5028, 2013-12-5019. These projects have been carried out thanks to the Training for Teaching Innovation Program, Innovation and Good Teaching Practices Plan of University of Córdoba (Spain).

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