Computers & Education 102 (2016) 172–187

Contents lists available at ScienceDirect

Computers & Education

journal homepage: www.elsevier.com/locate/compedu

Student evaluation of a virtual experience for project management learning: An empirical study for learning improvement

Ana González-Marcos [a,*], Fernando Alba-Elías [a], Fermín Navaridas-Nalda [b], Joaquín Ordieres-Meré [c]

[a] P2ML Research Group, ETSII, Universidad de la Rioja, c/San José de Calasanz 31, 26004, Logroño, La Rioja, Spain
[b] Department of Education, Universidad de la Rioja, c/Luis de Ulloa 2, 26004, Logroño, La Rioja, Spain
[c] PMQ Research Group, ETSII, Universidad Politécnica de Madrid, c/José Gutiérrez Abascal 2, 28006, Madrid, Spain

A R T I C L E I N F O

Article history:
Received 9 February 2016
Received in revised form 18 August 2016
Accepted 19 August 2016
Available online 21 August 2016

Keywords:
Project management
Situated learning
Student satisfaction
Student performance
Virtual teams

A B S T R A C T

Project management education was designed traditionally according to an expository paradigm. However, it needs to be redefined to engage students in higher order thinking and to facilitate effective learning. This study proposes a student-centered approach that is aligned with situated learning theory in virtual teams and explores its impact on student satisfaction and learning outcomes. Using a quasi-experimental design, 122 undergraduate and master's degree students enrolled in project management courses at two universities in separate locations. They were separated randomly into two groups, an experimental group in which students used the proposed student-centered approach and a control group in which students followed a more traditional course design. Data analysis indicated a higher level of satisfaction and performance with the proposed methodology. These results suggest that the presented methodology, which was based on project-based learning in an authentic context that offers opportunities for students to experience virtual teamwork, was more effective than traditional teaching approaches. Furthermore, there were some positive and significant correlations between students' satisfaction and their final marks. In this matter, the most relevant aspects to facilitate students' academic performance were (1) positive expectations of future professional development, (2) clear learning objectives that consistently relate to the content of the course, (3) positive feelings induced by teachers' support in resolving doubts, and (4) academic self-perception. The findings of this study suggest that motivational and affective states influence student learning in higher education. This is consistent with current learning theories.

1. Introduction

Project management education was designed traditionally according to an expository paradigm and accompanied by exercises to apply a particular technique or use a specific tool. However, exercises or case studies do not provide sufficient

* Corresponding author.
E-mail addresses: ana.gonzalez@unirioja.es (A. González-Marcos), fernando.alba@unirioja.es (F. Alba-Elías), fermin.navaridas@unirioja.es (F. Navaridas-Nalda), j.ordieres@upm.es (J. Ordieres-Meré).

http://dx.doi.org/10.1016/j.compedu.2016.08.005

stimulus to engage students adequately to facilitate effective learning (Barron, 2005). Recent literature indicates that teaching and learning project management has grown in interest and popularity (Berggren & Söderlund, 2008; Ojiako, Ashleigh, Chipulu, & Maguire, 2011; Salas-Morera, Arauzo-Azofra, García-Hernández, Palomo-Romero, & Hervás-Martínez, 2013). Indeed, it is well accepted now that new and non-traditional initiatives are required. It is important to ensure that students engage in higher order thinking and learning (Roger, 2008).

This need for change in the teaching methodologies in higher education is also promoted by the Bologna process of creating a European Higher Education Area (EHEA). Thus, consistent with the principles underlying this process (promoting the mobility of students, teachers and research and ensuring high-quality learning and teaching), the adoption of a new training model that is focused on learning (Prague Communiqué, 2001) is remarkable. In placing learning at the center of attention of higher education, a need arises to readjust the teaching methodology to the needs and conditions of the students.

In this new period of reflection, it makes little sense to insist that the future of Europe will be a society of lifelong learning – the first strategic objective established by the “Strategic Framework for European Cooperation in Education and Training (ET 2020)” (European Council, 2009) - if teachers that are responsible to transform the new educational theory into practice continue to guide the cognitive activities of students to simple processes of repetition of concepts. Therefore, within the ‘ET 2020’, the adoption of *student-centered* teaching approaches has led to an important change in teachers' methodological practices. This is necessary to respond effectively to the need to ensure that there is a quality learning environment in the educational systems (ENQA, 2010; ESU, 2012; European Commission, 2013). More specifically, it has questioned the value of the dominant transmission model in higher education (Zabalza, 2011, p. 78), which emphasized the need to redefine to a great extent the traditional roles of teachers and students (European Commission, 2005, p.4).

Undoubtedly, all this constitutes a powerful motor for innovating and improving the quality of teaching and learning processes in higher education in the field of project management.

As part of the process of acquiring the skills needed to become project management professionals, a learning process should provide students with experiences that are similar to what they will encounter in the working world, i.e., an *authentic context*, (Caulfield, Veal, & Maj, 2011; Ku, Fulcher, & Xiang, 2011). This is in line with the theory of *situated learning* (McLellan, 1996; Orgill, 2007, pp. 187–203), which is based on the proven idea that meaningful learning by the student cannot be considered outside an authentic context in which it occurs. Therefore, the teacher's function can no longer be limited to transmitting decontextualized curriculum content to students (Ginns, Kitay, & Prosser, 2008; Navaridas, 2004, p. 48, p. 177). Instead, the instructor's role is to design *relevant learning situations* (Huber, 2008; Jonnaert, 2002; Niemeyer, 2006) to enable students to build applications or refutations of knowledge and also to develop contextualized skills in their immediate social, cultural and professional environments. Thus, with the teacher's expert help, the students become the main actors and are responsible for their own learning process.

However, the ability to work in teams and to communicate effectively in visual, written and oral form is deemed to be an essential skill for a project management professional. This is particularly important when design team members are dispersed across multiple locations and meet in a virtual environment (van Rooij, 2009). In this sense, *project-based learning* (PBL) promotes teamwork (Kloppenborg & Baucus, 2004) and the development of skills in communication, negotiation, and collaboration (Bell, 2010). PBL has proven to be particularly effective when combined with Information and Communication Technologies (ICT) (Edelson, Gordin, & Pea, 1999; Solomon, 2003). In this sense, it is worth mentioning that ICT offer different benefits and educational opportunities in the teaching and learning process. For example, the use of ICT can address students' individual learning needs and provide personalized guidance and support (Mama & Hennessy, 2013; Santos & Boticario, 2015). Furthermore, recent studies have identified significant relationships between the use of ICT and students' perceived learning achievements and satisfaction (Paechter, Maier, & Macher, 2010; Valentín et al. 2013).

Recent studies specifically consider the difficulties that students experience in learning project management topics (O'Dowd, 2013; Salas-Morera et al., 2013). Even when they are focused on international students' performance, most of their analyses are fully applicable to the general situation. It becomes quite clear that a combination of knowledge and a constructivist approach would provide some kind of experiential learning environment that would help to address the challenges of training successful project managers from the halls of academia.

An interesting initiative was proposed by (Nooriafshar, 2013). That author demonstrated the relevance of simulated life-cycle environments for learning project management. The present work extends his proposal by not considering replication on different campuses, but by getting participants to work together, even when they study at different campuses. Thus, an additional layer of complexity is created by the use of *virtual teams* in an attempt to enhance collaboration and a cooperative learning experience (Johnson, Suriya, Won Yoon, Berrett, & Lafleur, 2002; van Rooij, 2009). It is important to note that globalization and the rapid development of ICT have increased the use of virtual teams in current organizations (Hertel, Geister, & Konradt, 2005; Peñarroja, Orengo, Zornoza, Sánchez, & Ripoll, 2015). Using virtual teams not only promotes knowledge sharing and application, but also enhances the acquisition of special skills. The latter include an understanding of human dynamics across functional and cultural boundaries, which is necessary to lead and work in virtual teams in many organizations (Duarte & Snyder, 2006).

Another interesting framework is presented in (Warin, Kolski, & Sagar, 2011). These authors discovered that students experience difficulties in identifying the usefulness of certain theoretical knowledge in the professional context when teaching methodologies consist mainly of lectures or seminars. The lack of activities that promote the acquisition of interpersonal skills, such as motivation or teamwork, cause students to be less attractive to prospective employers in the future. Since companies currently seek engineers who have both acceptable expertise and the abilities to “connect” with other company employees, these authors propose some principles that encourage the addition of professional, methodological and meta-cognitive competencies to knowledge acquisition modules. Thus, students are provided with more appropriate courses. Because we have identified the same deficits as Warin et al. (2011), the proposed methodology is based mainly on those principles. As explained in the next section, each principle has been adapted to the learning objectives of the subject, as well as to the affiliation of students and teachers involved. The present work is considered to be innovative because it extends the proposal by those authors to include a new method for evaluating technical and interpersonal skills (*competence monitoring*), and to enhance the use of ICT tools that are most often used by professionals who manage real projects.

In summary, this study presents a framework that is aligned with the underlying principles of the new educational model that is proposed in the EHEA. Students are **situated** in a **project** development process that is interesting and useful to them and in which their individual differences are considered. Furthermore, **self-directed learning**, **learning by doing and a sense of responsibility are fostered**. Also, our work extends previous investigations by including **virtual teams** and **competence monitoring**. Because of the importance of all these contributions to innovation and improvement of the quality of teaching and learning processes in higher education in the field of project management, our research questions were:

RQ1 - *Does a methodology that is based on PBL in an authentic context that offers opportunities for students to experience virtual teamwork improve the overall level of student satisfaction with the teaching and learning of the subject?*

RQ2 - *Does the use of an innovative methodology that is based on virtual teamwork improve students' academic performance significantly?*

2. A framework for project management learning

As a result of the challenges that are mentioned in the previous section in regards to the instruction of project managers, it is clear that transformational leadership and/or reciprocal, shared leadership process "knowledge" is not well represented at present in project management education programs. A second set of needs that have not been well-addressed, is "social architecture" development, including a culture of shared values, a powerful vision, decision making, team development, and team leadership. Indeed, most programs appear to concentrate on the technical aspects of project management. In summary, process-oriented knowledge must be delivered in educational programs. However, in addition, some kind of adaptation awareness should be introduced to conventional, linear, project management models and tools. To do this, it would be helpful to have a combination of a basic knowledge acquisition system and a socio-constructive approach that is based on lectures and discussion to produce a realistic simulation environment for practice. In this work, a framework for project management learning which was designed to promote "work-based learning" experiences is presented.

The adoption of such a practical environment requires establishment of a governance model during the course so that each participant will be aware of the operating principles. These principles were presented in Warin et al. (2011) (Table 1, right). As discussed previously, they encourage the addition of professional, methodological and meta-cognitive competences to knowledge acquisition modules. However, there is a need to adapt and extend those principles in order to align them to the characteristics of the project management subject, and to pay attention to the requests and recommendations that arise from the EHEA (the operating principles of the proposed framework that are presented on the left side of Table 1):

- First, the teaching and learning methodology should offer students real opportunities to act or apply the acquired knowledge. It is by these situations of authentic context that a greater level of intrinsic motivation and improved academic performance, as well as feelings of well-being and satisfaction with the results of the learning process can be seen (Bell, Maeng, & Binns, 2013). Thus, it is relevant to propose PBL to engage students in solving real-world engineering projects ([P.1]). This enhances the student's ability to undertake different project management roles with different responsibilities ([P.2]), as well as to employ ICT tools that professionals who manage real projects use and to permit working in virtual teams ([P.3]). The foregoing develops the capability to acquire and create knowledge and the context to share it for its effective use, and to maintain learning at all levels (i.e., individual, group, project and organizational) ([P.4]).
- Second, in accordance with the EHEA, educational systems are moving from an input-to an output-driven approach, with the quality of education judged on the knowledge and skills that students will require in their professional careers (Seidel,

Table 1
Comparison between the principles of the proposed framework and those presented by Warin et al. (2011).

Principles of the proposed framework	Principles presented by Warin et al. (2011)
[P.1] To establish a pedagogical project context that allows experiential learning.	[2] Introduce pedagogical mini-projects guided by cooperative learning
[P.2] To redefine the roles of teachers and students.	[1] Redefine the roles of teachers and students
[P.3] To use ICT to support learning and monitoring.	[5] Use ICT to support teaching
[P.4] To foster theoretical knowledge and practical work of individuals and groups in a harmonized way.	[3] Alternate individual work and group work
[P.5] To regularly evaluate the acquired competence level and knowledge.	[6] Evaluate the knowledge acquired by students regularly
[P.6] To provide understandable feedback on the development of student processes.	[4] Foster a shared understanding of the activities proposed to students
[P.7] To promote continuous improvement of the teaching process.	[7] Analyze the teaching process.

2012). Therefore, competence-based learning and assessment have become major concerns of higher education. In this sense, the proposed framework adds competence measurement by the use of several pieces of evidence to assess individual competences ([P.5]) and to provide feedback to students about their performance ([P.6]).

- Finally, the instructor's role is now up with that of a teaching professional who not only consciously considers what he/she is doing while doing it (reflection-in-action), but also reviews, analyzes, and evaluates his/her behavior after the event (reflection-on-action) (Schön, 1983). The main purpose of this reflective practice is to provide insights into practices that enhance teaching and learning ([P.7]).

Since our main interest is to promote high-quality learning, this study analyzes the impact of the proposed framework for project management learning on the student outcomes. They are measured in terms of satisfaction (*RQ1*) and academic performance (*RQ2*).

How the new principles are implemented and their impact is explained below.

[P.1] To establish a pedagogical project context allowing experiential learning

Students are involved in real-world engineering projects that provide authenticity. This requires them to use academic and technical knowledge. The method that was selected for project management, Prince2™ (Projects IN a Controlled Environment) (Office of Government Commerce, 2009), was adopted because it is professional, product-oriented and focused on managing by exception. Also, it enables clear identification of the tasks that should be performed in the project. This makes it suitable for students as it is closer to the activities in which they are engaged.

The use of Prince2™ is not new. It has been frequently reported (Hewagamage & Hewagamage, 2011; Zhang, He, & Zhang, 2012). We prefer it, rather than the more common standard from the Project Management Institute (PMI) – Project Management Body of Knowledge, PMBoK (PMI, 2008) - because of the students' lack of previous experience. After their initial experience with other methodologies (Alba-Elías, González-Marcos, & Ordieres-Meré, 2014), the authors found that concentrating on the products to develop, instead of a methodology that requires a great deal of effort, is of most help to the learning process, as students always concentrate on product level.

The projects provided are oriented to learning about project management methodology. They include preparation of reports, a video presentation of the project's tasks carried out and self-assessment, which is a beneficial to the learning process too (Zhang, Zhou, Briggs & Nunamaker, 2006).

Different topics have been selected to involve configuring a product or service, including feasibility analyses and formal design of the project's products. The project includes the preparation of the drawing, if required by the project topic, and development of a formal budget and its implementation.

The time allocated to the entire development is ten weeks. This includes all of the phases according to the students' own plan.

[P.2] To redefine the roles of teachers and students

Teachers and students are classical players in the process. Each has specific functions and roles. The teachers are responsible for defining and establishing the pedagogical project contexts, and also for organizing the group. Teachers are knowledge facilitators and academic referees. They perform the role of *corporate* (CO) in the Prince2™ method, allowing them to audit the work being done (*auditor*) (Fig. 1). These audits become a major source of applied knowledge as they reveal little-understood concepts behind the operating procedures as inconsistent pieces of evidence appear.

The students' stance must evolve from the classical passive approach, which they adopt in the behaviorist configuration, to a more participative one because they must play different roles in the pedagogical project context in which they become involved. Some students will be Project Board members—the *Executive* (EX) and some will be *Project Managers* (PM), *Team Managers* (TMg) or *Team Members* (TM). All of them are the available figures in Prince2™ as the lectures have made clear (Fig. 1):

- EX: This role is charged with effective management of the project.
- PM: On behalf of the EX, the PMs have the authority to manage the project on a day-to-day basis. PMs will delegate responsibility for the creation of products to the team manager.
- TMg: Team managers provide the daily management of the team members, making sure that products that the PMs request are produced. Some PMs adopt this role temporarily as the development of the project's products begins.
- TM: Team members are responsible for delivering the project products within the required quality, time and cost. They have development responsibilities for engineering tasks.

[P.3] To use ICT to support learning and monitoring

The ICT tools are used here as driving technology to promote the socio-constructivism and to acquaint the students with Project Management Information Systems (PMIS) as a common tool that they will encounter in their professional lives. In fact,

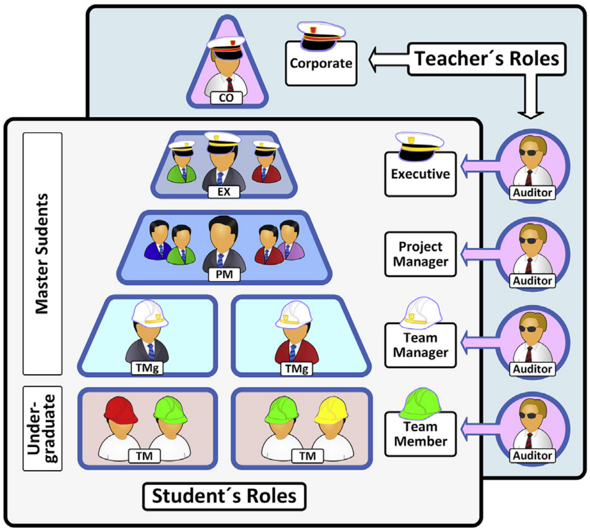

Fig. 1. Hierarchical project structure and roles assumed by teachers (CO and auditor) and students (EX, PM, TMg and TM).

the ICT will be used in an extended way to monitor their work at a low level. The data gathered will be used to measure the competence level of each individual.

The ICT environment provided was created by integrating open source tools, such as project.net community edition (http://www.project.net), for the project's portfolio management (PPM), a Moodle server for a content place for lectures, tests and socio-constructivist place, and limesurvey (https://www.limesurvey.org) as a survey collector. Other homemade tools included an auditing tool to check the integrity of performed actions and procedures, a system to report mistakes, a performance scoring system and a management tool to assign students to project contexts according to their roles. Integration was achieved by using an LDAP service for a single sign-on authentication (SSO) and using jQuery + AJAX technology to obtain live data in the form of options and as contextual data that are always relevant to the participant (Fig. 2).

Specific procedures that explain how to operate, how to do things, how to communicate mandatory information, etc., have been developed.

The developed ICT environment allows students from different universities and different locations to work as a team. Thus, it is possible to develop the proposed virtual experience.

[P.4] To foster theoretical knowledge and practical work of individuals and groups in a harmonized way

While the project is being developed, different students work together, although in different roles (see [P.3]). Some of them have accountability and leadership competences, such as the EX for the PMs or PMs for TMs. Furthermore, different perspectives of the project must be developed that are more holistic and less detailed for EX and PMs and less general and much more concentrated on detail for team managers and TMs. Several negotiations of scope, time scheduling, effort, quality, etc. must be completed out in different places.

Thus, students realize how complex project management can become due to different factors, such as the differing interests of stakeholders, misunderstandings, time pressures, particular motivations and lack of attention to details, etc. This procedure also shows how increasing complexity and uncertainty require greater managerial and leadership knowledge in our teaching of advanced project management (Thomas & Mengel, 2008).

Obviously, most of the work needs to be carried out by groups or teams, although based on individual knowledge. Sometimes it is improved by discussions of how to perform the work. Thus, the students are responsible for their learning, as well as that of others (Hughes, 2012).

[P.5] To regularly evaluate the acquired competence level and knowledge

The authors have chosen the IPMA-ICB framework (IPMA, 2006) as a reference model for competences in project management because of its flexibility and the taxonomy it provides. Thus, the proposed framework includes the assessment of 16 competences, namely 12 technical competences and four behavioral competences (Fig. 3a).

Evaluating the learning process is essential not only for students, but also for teachers as the latter are responsible for the learning process. Unfortunately, there is no agreement on how to integrate different dimensions of learning, knowledge, skills, etc. (Li & Huang, 2013). Thus, the authors have incorporated continuous assessment that is oriented to determining project management performance and each student's contribution (Qureshi, Warraich, & Hijazi, 2009). This project

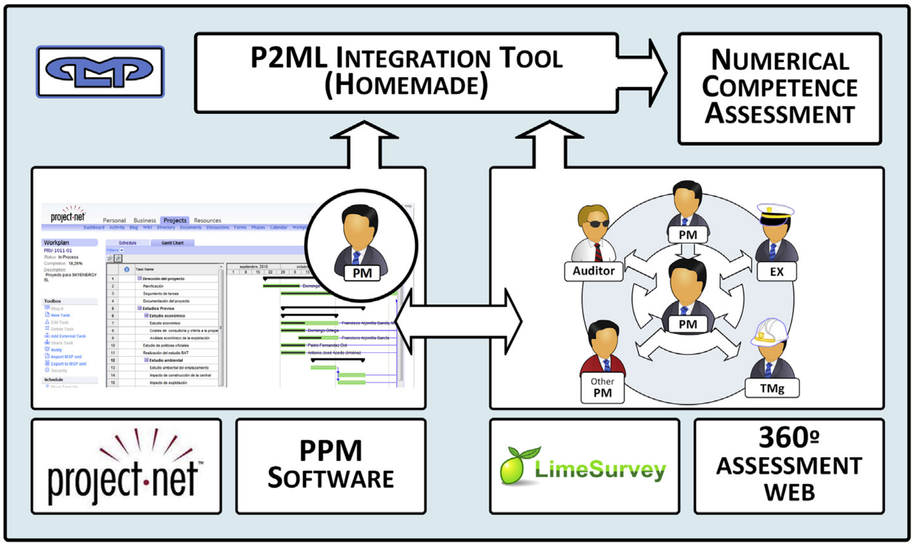

Fig. 2. An overview of the ICT tools provided for the learning experience.

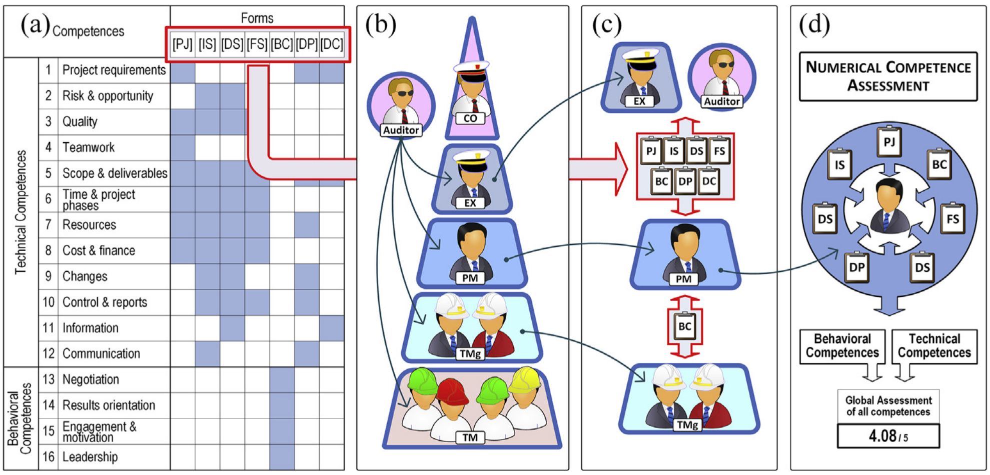

Fig. 3. (a) Project management competences considered and forms used in their assessment; (b) roles assumed by teachers and students (c) an example of a 360-degree assessment of a PM by use of the proposed forms; and (d) numerical competence assessment based on collected information.

performance is based on the auditing processes that is carried out by the EX and the owner's representatives (the teachers), and the competence level gained during the daily work.

The auditing process has two different parts. The first is performed automatically and looks for document consistency, checks integrity checks in planning and proper effort allocation, etc. The second asks for more qualitative information, although still evidence-based opinion, about the products being produced and how the team is managing the different Prince2™ themes – risk, communication, quality and configuration.

To determine the competence level, answers to different questions are solicited on different forms about products (Delivery Produced –DP–, Delivery Consumed –DC–), phases (Pre-Project –PJ–, Initiation Stage –IS–, Delivery Stage –DS–, Final Stage –FS–) and behavior (Behavior Competences –BC–) (Fig 3a). Assessment of each competence involves several pieces of evidence (at least one) on these forms, in which 5-point Likert scales are used for most questions. Opinions are sought not only from those who produce the product or are responsible for its process implementation, but also from various consumers of those products or participants in the process, in addition to the auditor (the teachers) (Fig. 3c). This information is gathered by means of the 360-degree assessment web mentioned in [P.3]. Finally, all of the numerical data that have been collected are integrated by considering different weights for different pieces of evidence, assessor figures (roles) and phases in which a competence is assessed (Fig. 3d). Thus, the competence assessment method, which is explained in González-Marcos, Alba-Elías, and Ordieres-Meré (2015), uses an integrated overview of different activities within the project.

[P.6] To provide understandable feedback on the development of student processes

Self-regulation requires that the student has goals against which he/she can compare and assess performance (Nicol & Macfarlane-Dick, 2006). In academic settings, specific targets, criteria, standards and other external reference points help to define goals. Feedback concerns how the student's present state (of learning and performance) relates to these goals and standards. Thus, providing clear and immediate feedback to students about their performance contributes to the effectiveness of the learning process (Epstein et al., 2010) as it enables the students to identify their mistakes and to improve their future performance.

In our case, there are two different types of feedback. Both are provided by the P2ML integration tool (Fig. 2).

- Each student receives a detailed report about the project as a whole and his or her own work. Students are given the right to order an on-line self-audit based on the automatic checks that were mentioned previously. The information used for this auditing system is gathered mainly from the PPM software.
- Also provided is a detailed report of the contribution of each product or procedure to the effort claimed by participants, average effort initially estimated from independent sources and contribution to the competence level attained. The software provides no way to rebuild the already delivered and approved items, but provides advice on how to proceed and how to improve in the future. In order to provide this report (competence assessment), the P2ML integration tool gathers information from the 360-degree assessment web and the PPM software.

Students generate internal feedback as they monitor their involvement with learning activities and tasks, and assess their progress towards their goals.

[P.7] To promote continuous improvement of the teaching process

Learning from experience is complex and depends on the learner, the task and the context. Therefore, experiential learning and competence development on the job require an active partnership between the learner and the organization in which the experience takes place. This includes the individual's preparedness and skills in order to learn from experience, the work experience, the guidance, the support, and the encouragement provided by the organization. It also includes project management competence and the organization's approach to transformative experiential learning in terms of its structures and systems (Turner, Keegan, & Crawford, 2000, pp. 21–24).

Based on the previous factors, expectations of better performance in teaching and production of efficient and competent graduates are increasing. A failure to fulfill such expectations causes students to become frustrated by their experience as customers. In turn, this requires a change in the programs that higher education offers, as recognized by researchers (Kuo, Walker, Schroder, & Belland, 2014; Yarmohammadian, Mozaffary, & Esfahani, 2011). A specific survey of students' feelings about the experience and their perceptions was developed to collect quantitative data and feedback from learners at the end of the course. This is detailed in Section 3.3.1.

Finally, a pre-/post-test evaluation (see Section 3.3.2) was conducted by means of a technical survey. It included broader concepts than those reviewed in the course as it provides indirect information of how much the specific or general experience changed the students' minds.

3. Method

3.1. Design

A quasi-experimental study was conducted to evaluate the proposed methodology for project management learning. The theoretical content of the course was the same for all students and was based on Prince2™ methodology (Office of Government Commerce, 2009) and IPMA competences (IPMA, 2006). Thus, all students acquired the same project management theoretical knowledge. However, in order to conduct this study, two different sections of the same course were used for the practical activities. One course section –the experimental group– used the proposed methodology that was described in Section 2. Students from different universities in different locations were organized in virtual project teams. They were able to use the complete set of ICT tools that were provided. Various types of feedback were provided to them. The other course section – the control group – used a more traditional course design in which students from the same university were organized in local project teams. In this case, the students were able to use only some of the provided ICT tools. Moreover, instead of the feedback that the P2ML integration tool provides, students used only the instructor-provided tips and the best practices that are normally used for project management. Table 2 indicates the differences between both experimental and control groups based on the proposed principles. As can be seen, there are three main differences:

1. The way in which the project management standard is followed (Prince2™). The use of Prince2™ is mandatory for the experimental group, whereas the control group is permitted to adapt this methodology ([P.1]). As a result, the number of roles played by the two groups differed ([P.2]).

Table 2
Differences between the two course sections in proposed principles.

Principles	Course section	
	Experimental group	Control group
[P.1]	Formal Prince2	Student-adapted Prince2
[P.2]	Students have four roles: EX, PM, TMg and TM	Students have two roles: PM and TM
[P.3]	ICT tools: PPM, 360-degree assessment web, P2ML integration tool, Moodle	ICT tools: 360-degree assessment web, Moodle
[P.4]	Individual and team work developed in virtual teams	Individual and team work developed in local teams
[P.5]	Technical and behavioral competences assessment on a regular basis	Behavioral competences assessed at the end of the course
[P.6]	Established and regular feedback using the P2ML integration tool	Feedback as requested by the student
[P.7]	Satisfaction (SERVQUAL) and technical (Prince2™) surveys	Satisfaction (SERVQUAL) and technical (Prince2™) surveys

2. The ICT tools used by the students. The experimental group developed the project with the entire set of ICT tools that was provided, whereas the control group used only the 360-degree assessment web to assess the behavioral competences of these students ([P.3]). Because of the use of the provided ICT environment, it was possible to design virtual project teams for the experimental group ([P.4]).
3. The nature of the competences assessed and the feedback provided. Based on the information gathered from the ICT tools, there was continuous assessment of both technical and behavioral competences for the experimental group ([P.5]). Also, because of the information gathered and integrated, it was possible to provide different types of feedback to students from the experimental group ([P.6]). However, only behavioral competences were assessed for the control group, because technical aspects of this group were evaluated only according to the quality of the project's products at the end of the course. As mentioned above, instead of the feedback provided by the P2ML integration tool, students from the control group used only the instructor-provided tips and best practices that are normally used for project management.

Finally, the two groups of students were similar in one aspect. Both groups provided feedback about their learning process ([P.7]). Therefore, this study was carried out by the use of surveys. This was the most suitable procedure for collecting students' opinions relatively quickly and accurately. Also, a pre-test/post-test evaluation was conducted in order to assess participants' understanding of new concepts that were presented in the course.

To ascertain whether the perceptions and results of the experimental group and control group differed significantly, we used the t-test for independent samples (or Mann–Whitney U test when conditions for t-test could not be assured). The level of significance (alpha) was determined to be 0.05.

3.2. Participants

The participants in this study were undergraduates and master's degree students who were enrolled in project management courses scheduled for the fall semester of two universities that are located in different regions of Spain. Thirty-six master's degree students and thirty-eight undergraduate students were from the Technical University of Madrid (UPM), and twenty-eight master's degree students and twenty undergraduates were from the University of La Rioja (UR).

Because of the number of participants, the students were divided into eight project teams, each of which consisted of 15 or 16 project members. The groups were formed on the basis of the degree program and geographical location. Thus, the experimental group consisted of five virtual project teams and the control group consisted of three local project teams (Table 3).

Cooperation between students from the two degree programs was peer-to-peer within each project. This cooperation was established mainly for practical activities, since the theory involves different topics: project management for master's degree students and project engineering for undergraduates. Accordingly, the assigned roles depended on their degree: EX and PM/TMg for the master's degree students and TM for the undergraduate students.

Table 3
Distribution of students according to their role, assigned project, and university.

Course section	Project number	EX	PM (TMg)	TM	Total
		UPM/UR	UPM/UR	UPM/UR	
Experimental group	1	2	6 (2)	7	15
	2	2	6 (2)	7	15
	3	2	6 (2)	7	15
	4	2	6 (2)	7	15
	5	2	6 (2)	8	16
Control group	6	–	8/–	7/–	15
	7	–	8/–	8/–	16
	8	–	–/8	–/7	15
Total		5/5	31/23	38/20	122

At the end of the course, 73 students from the experimental group and 36 students from the control group completed the satisfaction questionnaire and the pre-test/post-test questionnaires. Thus, on the basis of this sample size, a desired power of 0.99 and a desired significance level (alpha) of 0.05, we obtained an effect size of 0.81, indicating a large effect size.

3.3. Instruments

3.3.1. Student satisfaction questionnaire

Student satisfaction was measured by means of an *ad hoc* questionnaire that was based on SERVQUAL (Parasuraman, Zeithaml, & Berry, 1985, 1988). The latter was developed in the eighties to measure the scale of quality in the service sectors in order to provide a service quality framework. It is based on the assumption that dissatisfaction occurs when the perceived quality is lower than expectations. This questionnaire originally measured 10 aspects of service quality, but in 1988 the 10 components were collapsed into five dimensions. Reliability, tangibles and responsiveness remained distinct, but the other seven components (competence, access, courtesy, communication, credibility, security and understanding the customer) were combined to form two aggregate dimensions - assurance and empathy. The SERVQUAL scale has been tested empirically and validated for a wide variety of services (Buttle, 1996). It also has been applied in the teaching arena (Chen, Lee, & Chen, 2005; Lee, Yoon, & Lee, 2009; Stodnick & Rogers, 2008). To conduct this study, we adapted the original 22-item five-dimension SERVQUAL based on the EHEA and higher education context in our country.

The adapted SERVQUAL was tested for content validity based on the dimensions and items that we identified as being most relevant from a theoretical framework to the specific problem being considered. Also, in accordance with the classic patterns of testing the validity of theoretical content and meaning of a survey (Gómez, Rodríguez & Ibarra-Sáiz, 2013, p. 204), seven experts in the field of educational research were asked to assess various aspects. These were: clarity of both instructions and purpose of the questionnaire, structure and relevance of the proposed elements (dimensions and items), accuracy of questions, the overall rating and the possibility of adding or removing any element. The final version of the survey incorporated the changes and improvements that were made according to the comments and suggestions of the seven experts. Thus, the final version consists of 17 questions (items) about the following six dimensions (Table 4):

1. **Access**: Teachers pay attention to individual student needs and make it easier for their students to follow up the teaching and learning process.
2. **Tangibles**: Availability and performance of physical facilities and technological resources.
3. **Reliability**: Ability and organization of the educational program to meet the learning objectives.
4. **Competence**: Knowledge, experience and skills required of teachers to ensure academic performance.
5. **Responsiveness**: Willingness and flexibility of teachers to face the problems and difficulties raised by students.
6. **Relevance**: Appropriateness of the duration and time distribution of the course to facilitate students' learning development in their usual or future performance.

The students were asked to indicate their agreement or disagreement with each statement on a five point Likert-type scale that ranged from 1 to 5, where 1 indicated strong disagreement and five indicated strong agreement. In order to determine the reliability of the 17-item instrument, we used Cronbach's alpha. It yielded a value of 0.76 for Access, 0.79 for Tangibles, 0.8 for Reliability, 0.76 for Competence, 0.77 for Responsiveness and 0.74 for Relevance. The Cronbach's alpha of the entire scale was 0.85, which exceeds the 0.7 threshold that is recommended by Nunnally (1978).

Table 4
Questions used to measure students' satisfaction.

Dimension	Label	Item
Access	A.1	I was able to coordinate the attendance at this course with my work responsibilities.
	A.2	The course information provided an overview that allowed me to organize my personal agenda properly.
Tangibles	B.3	The physical environment of the classroom aids learning.
	B.4	The technological resources were operating throughout the learning process.
Reliability	C.5	What I learned from this course is aligned with the course learning objectives.
	C.6	The learning objectives relate consistently to course contents.
	C.7	The learning strategy has increased my subject knowledge.
	C.8	The learning strategy has improved my skills in the subject.
	C.9	The theory and practice have been adequately balanced.
Competence	D.10	The instructor is knowledgeable in his/her field.
	D.11	The instructors' professional experience fosters a better understanding of the subject.
	D.12	The instructor provides good materials for properly follow up of the teaching sessions.
Responsiveness	E.13	The instructor responds quickly and efficiently to students' questions.
	E.14	The instructor properly coordinates students' interventions.
	E.15	The staff is interested in students' problems and difficulties.
Relevance	F.16	The duration of the course is appropriate to achieve the intended objectives.
	F.17	I can improve my professional competences because of what I learned.

3.3.2. Pre-test/post-test evaluation

A pre-test/post-test questionnaire was adopted to determine how well the proposed methodology had improved the acquisition of project management concepts. The pre-test was administered at the beginning of the course and the post-test was conducted at the end of the course, after the projects had been completed.

The instrument that was used to measure the students' learning outcomes was a specially designed conceptual evaluation that included all of the project management themes that were reviewed in the course –scope, planning, control, risk, quality, communication, etc. – and also asked questions about broader concepts. Thus, 53 questions were used to obtain indirect information of the extent to which the learning experience had changed the students' minds. A check of the internal consistency of this instrument yielded a Cronbach's alpha of 0.74, which exceeds the minimum value of 0.7 that is required to prove reliability.

3.3.3. Final mark

A student's final mark in the course was determined by a weighted average of the marks that he or she received in the final exam (40%), the project's product quality (40%) and behavioral competences (20%). Because technical skills were not assessed for the control group and there was a desire to assess both groups in the same way, these skills were not included in the final mark. The authors will include the assessment of technical competences according to [P.5] after this new methodology has been consolidated and all students take the same course.

The final exam was based on the Prince2™ Practitioner Level (Turley, 2010) to determine if a candidate could apply Prince2™ to the operation and management of a non-complex project within an environment that supports it. However, a grading rubric that was distributed to students at the beginning of the course was used to assess the final project deliverable. Projects from both the experimental and control teams were graded by means of the same rubric. Finally, five behavioral competences were assessed according to the chosen reference model IPMA-ICB (IPMA, 2006) on leadership, engagement & motivation, results-orientation, teamwork and negotiation. The assessment of these competences is described in González-Marcos, Alba-Elías, Ordieres-Meré, and Navaridas-Nalda (2015).

4. Results

4.1. Student satisfaction (RQ1)

Descriptive statistics of each investigated dimension appear in Table 5 to summarize the student perceptions that were collected in the satisfaction survey. Although these results indicated a high level of satisfaction in both groups, the scores for the experimental group are slightly more favorable with a mean value of 4.016.

Based on the descriptive statistical data, the most valuable component for students in the experimental group was the *responsiveness* dimension (mean value of 4.304), i.e., the instructor's support. The regular feedback that was provided to students of the experimental group ([P.6]) could help to explain this score. This is interesting because it indicates that the developed ICT environment is useful in supporting learning and monitoring ([P.3]), as much of the feedback is based on the information gathered and integrated by it. However, this group was less satisfied with the *tangibles* dimension (mean value 3.565), that is, with the availability and performance of physical and technological resources. It is worth mentioning that there were a few problems in the server machine – the hardware rather than the software – and, thus, ICT tools were temporarily unavailable.

With regard to the control group, the highest level of satisfaction of these students was for ease of coordination of course activities with other responsibilities – the *access* dimension (mean value of 4.231). However, they perceived lower levels of satisfaction with the duration and time distribution of the course – the *relevance* dimension (mean value of 3.538), and the alignment and relationship between course activities and learning objectives – the *reliability* dimension (mean value of 3.570).

In addition to an examination of the descriptive statistics, a further analysis of the students' responses was conducted to determine if students' satisfaction in the two groups differed in their mean ratings. Because most of the variables do not follow a normal distribution, the Mann-Whitney U test was applied. The effect size was calculated by means of Cliff's Delta

Table 5
Descriptive statistics: mean, standard deviation, maximum and minimum values for the investigated dimensions.

	Experimental group (n = 73)				Control group (n = 36)			
	Minimum	Maximum	Mean	Std. deviation	Minimum	Maximum	Mean	Std. deviation
Access	2	5	4.026	0.859	3	5	4.231	0.764
Tangibles	1	5	3.565	1.041	1	5	3.885	1.107
Reliability	1	5	4.025	0.941	1	5	3.570	0.770
Competence	2	5	4.054	0.883	2	5	4.051	0.857
Responsiveness	2	5	4.304	0.655	2	5	4.153	0.471
Relevance	3	5	3.975	0.768	1	5	3.538	0.948
TOTAL			4.016	0.892			3.875	0.838

Table 6
Differences between the means of the experimental group and control group according to their satisfaction scores.

Item	Experimental group (n = 73)		Control group (n = 36)		Mann-Whitney *U* test		Effect size
	Mean	Std. deviation	Mean	Std. deviation	*Z*	*p*	Cliff's Delta
Access							
A.1	4.077	0.954	4.384	0.650	−0.7517	0.5350	−0.20 [−0.49, 0.12]
A.2	4.000	0.842	4.077	0.862	−0.2655	0.8010	−0.03 [−0.27, 0.22]
Tangibles							
B.3	3.714	1.118	4.308	0.751	−1.7068	0.0908	−0.34 [−0.54, −0.11]
B.4	3.414	0.947	3.461	1.266	−0.5768	0.5714	−0.13 [−0.38, 0.14]
Reliability							
C.5	3.898	0.823	3.923	0.641	−0.1017	0.8951	−0.05 [−0.27, 0.26]
C.6	4.061	0.827	3.308	0.480	3.0341	0.0023**	0.55 [0.36, 0.71]
C.7	4.469	0.649	3.769	0.832	2.7956	0.0048**	0.49 [0.24, 0.69]
C.8	4.469	0.616	3.692	0.480	3.7272	<0.001***	0.63 [0.48, 0.75]
C.9	3.225	1.123	3.154	1.068	0.1267	0.9064	0.02 [−0.22, 0.26]
Competence							
D.10	4.143	0.764	3.923	0.954	0.6826	0.4984	0.12 [−0.14, 0.36]
D.11	4.308	0.855	4.000	0.816	0.9857	0.3726	0.14 [−0.19, 0.44]
D.12	4.025	0.984	4.214	0.832	−1.0316	0.3121	−0.15 [−0.37, 0.95]
Responsiveness							
E.13	4.368	0.676	4.128	0.220	2.0098	0.0443 *	0.35 [0.12, 0.57]
E.14	4.247	0.387	4.192	0.325	0.1830	0.8599	0.06 [−0.20, 0.32]
E.15	4.296	0.832	4.246	0.356	1.2251	0.2251	0.32 [0.10, 0.51]
Relevance							
F.16	3.571	0.707	3.077	0.862	1.6232	0.1126	0.29 [0.06, 0.49]
F.17	4.378	0.600	4.000	0.816	1.5270	01283	0.27 [−0.02, 0.52]

*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

instead of Cohen's *d*, because it is a suitable method for evaluating ordinal data. The magnitude is assessed using the thresholds provided in (Romano, Kromrey, Coraggio & Skowronek, 2006), i.e. $|d| < 0.147$ "negligible effect", $|d| < 0.33$ "small effect", $|d| < 0.474$ "medium effect", otherwise "large effect". Table 6 summarizes the *U* test results and the magnitude of the observed effects with their confidence intervals.

According to the students' scores that are presented in Table 6, the perceived satisfaction of experimental group members was higher than that of control group members for 12 of the 17 items, particularly in the *reliability* and *relevance* dimensions. The results of the *U* test of independent samples indicate that there is a statistically significant difference between the experimental and control groups for three of the five items within the *reliability* dimension (C.6, C.7 and C.8). However, there is no statistically significant difference between the two groups for any of the items within the *relevance* dimension. Item C.6 asks about the consistency between the learning objectives and the course contents. In this case, the experimental group scores were higher than the control group scores. A Cliff's delta quantifier value of 0.55 indicates a large effect size. Items C.7 and C.8 are related to the improvement of both knowledge and skills in project management. This indicates that the proposed framework improves students' perceptions of their learning achievements. Again, these items showed a large effect size.

Another item with a statistically significant difference between the experimental and control group is E.13 within the *responsiveness* dimension. Both groups recognized the instructor's effort to respond to learners rapidly and efficiently, although the scores for the experimental group were higher than those for the control group. Again, the developed ICT environment could partially explain this result, as it provides useful information to instructors and facilitates the teaching process. The Cliff's delta value indicated a medium effect size (0.35).

As a conclusion, we can state that the proposed methodology improved the perceived level of satisfaction of students with regard to both *reliability* and instructor's ability to provide prompt support.

4.2. Learning outcomes (RQ2)

Before analyzing the differences in learning outcomes between the experimental group and the control group, the students' previous knowledge of project management was analyzed. Table 7 summarizes the students' results of both the pre-test and the analyzed learning outcomes (pre-test/post-test evaluation and final mark).

The results of the pre-test show that (1) the students' lack of knowledge of project management and (2) the average number of correct answers were very similar, with slightly higher scores for students from the control group. The *t*-test indicated that there is no statistically significant difference in the pre-test results between the two groups. The effect size was small too.

For the learning outcome, the pre- and post-tests showed an increase in the average number of correct answers in both groups. In this case, the improvement score (difference between the post-test and pre-test scores) of the experimental group was higher than that of the control group. As for the final marks, the mean score for the experimental group was 7.98 out of 10,

Table 7
Results of the *t*-test for the pre-test and the learning outcomes.

Variable	Experimental group (n = 73)		Control group (n = 36)		*t*-test		Effect size
	Mean	Std. deviation	Mean	Std. deviation	*t*	*p*	Cohen's *d*
Pre-test score (10-point scale)	2.972	1.057	3.149	0.801	−0.8867	0.3789	−0.18 [−0.59, 0.22]
Improvement score (post-test−pre-test)	3.056	1.102	2.192	1.206	3.2062	0.0026**	0.65 [0.24, 1.07]
Final mark (10-point scale)	7.978	1.309	6.925	1.425	3.3032	0.0020**	0.67 [0.26, 1.09]

**$p < 0.01$.

and the mean score for the control group was 6.93 out of 10. Again, the *t*-test for independent samples was used to analyze the statistical significance of these results. With a significant level (alpha) of 0.05 (5%), the *t*-test rejects the null hypothesis that the means of both groups are equal. The Cohen's *d* value indicates a medium effect size for both learning outcomes. We found that these instruments had a power of 88% and 90% at a confidence level of 95%, respectively. This means that the proposed methodology contributes to improve the acquisition of project management concepts and learning achievements. It is worth mentioning that one student from the control group had a lower number of correct answers in the post-test than in the pre-test. This student also obtained the worst final mark for the course.

In summary, students from the experimental group perceived that the proposed methodology helped to improve their learning achievements. We can conclude that the proposed framework, which is based on PBL in an authentic context and virtual teamwork, improves significantly the academic performance of students.

These results are similar to those obtained by other studies of teaching practices and student performance. This shows that use of modern teaching practices, such as teamwork with defined roles ([P.1]), increases remarkably the reasoning ability of students (Bietenbeck, 2014; Harris & Sass, 2011; Méndez, 2015; Warin et al., 2011). Furthermore, as other authors have indicated (Epstein et al., 2010; Wolsey, 2008), providing students with formative and immediate feedback ([P.6]) helps them to identify their strengths and weaknesses, revise their work, and continuously refine their understanding. Thus, feedback can foster student engagement and improve the effectiveness of the learning process. In our approach, only the experimental group was provided with regular feedback through the developed ICT tools.

Finally, it is worth mentioning that, although the use of virtual teams a priori could pose difficulties for project development (McGrath & Hollingshead, 1994), this was not the case within the experimental group, where teams included students from two universities in different locations. According to Haines (2014), the project members of successful virtual teams (1) should have clear, specific goals, and (2) should be encouraged or even required to communicate with each other. We were able to satisfy these requirements because the proposed framework is based on a well-structured methodology with tasks that are clearly defined ([P.1]) and specific procedures that explain how to communicate mandatory information through the ICT tools that have been developed ([P.3]).

4.3. Correlations

The effect of students' satisfaction with their academic achievement was also analyzed. To quantify this factor, we used the Spearman's correlation coefficient, which measures the strength of a monotonic relationship between paired data. The test showed four positive and significant correlations between the students' satisfaction and their final mark: the consistency between learning objectives and course contents −item C.6-($r = 0.294$, $p = 0.0031$), the self-perception of knowledge acquisition in the subject matter −item C.7-($r = 0.246$, $p = 0.0094$), the instructor's support −item E.13-($r = 0.262$, $p = 0.0087$), and an expectation to improve professional competence −item F.17-($r = 0.355$, $p = 0.00032$). The statistical power found for these correlation coefficients was of 88%, 74%, 79% and 97%, respectively.

5. Discussion

In this study, we empirically examined the impact of a virtual experience for project management learning on student satisfaction and learning outcomes.

5.1. Student satisfaction (RQ1)

The results reveal that there should be clear and well-defined learning objectives that help students to acquire knowledge in a coherent and organized way when planning the teaching and learning (Mayer, 2004, p. 14). Thus, when the proposed methodology emphasizes these characteristics (clarity, fundamental unity and coherence of the curriculum), students seem to experience a higher level of satisfaction (experimental group) than when the importance of these methodological characteristics is not recognized (control group). Furthermore, students' perceptions of learning achievements and course satisfaction improve when the learning goals are clear, students are provided with authentic contexts and activities, students adopt an active role during the learning process and collaborative learning is facilitated (Paechter et al., 2010; Pérez-Sanagustín, Muñoz-Merino, Alario-Hoyos, Soldani & Delgado Kloos, 2015).

This study also provides evidence of the importance of the instructor's support and guidance. This is consistent with other studies that emphasize how, in the students' experience, the instructor's support is especially important for learning achievements and course satisfaction (Ozkan & Koseler, 2009; Paechter et al., 2010).

The study also highlights that, although flexibility could stimulate students' motivation (Gikandi, Morrow, & Davis, 2011), a greater autonomy and flexibility could lead to students' frustration, which is in line with the study carried out by Smith (2007). This was the case of the control group. These students were free to determine the specific details of their project management (Prince2™) methodology. Thus, due to their decision to minimize the activities that are included in the Prince2™ methodology, such as project control mechanisms (highlight reports and checkpoint reports, etc.), they experienced some inconsistencies between different pieces of work and required additional time to repeat that work. In addition, since the duration of the course was the same for both groups, when students in the control group needed time to repeat some of their work, they had less time in which to utilize the project management concepts and techniques. As a consequence, students from the control group were unable to indicate how their activities related to the learning objectives, their perceptions of learning achievements were worse than the perceptions of the experimental group (*reliability*). At the same time, they were less satisfied with the *relevance* dimension. This results are in line with (Gikandi et al., 2011), who argued that it is important to determine the appropriate level of students' flexibility and autonomy. These authors also argued that autonomy should be limited in cases where processes and/or approaches need to be closely followed, which is our case with the project management standard used in the course (Prince2™).

Finally, it is noteworthy that students from both groups were critical of the allocation of time between theory and practice (item C.9), the performance of the technological resources (item B.4), and the time available in which to achieve the intended objectives (item F.16). In regard to the first item (C.9), although the theory is usually focused on providing students with the knowledge and tools before they are put into practice in the development of the project, the tools and information were occasionally provided only after a particular event had occurred. The latter seeks to relate to a specific situation or problem that the students have encountered to a specific lecture or topic and, thus, to the course aims. However, in some cases, it could lead to feelings of stress or uncertainty. The students' scores for the second item (B.4) could be explained by the fact that the server experienced some problems during the course, as mentioned above. This highlights the importance of providing adequate and reliable resources for technology-mediated distance learning, which is in agreement with the findings of other studies (Ozkan & Koseler, 2009; Wang, Wang, & Shee, 2007). Lastly, it is well-recognized in the literature (Von Wangenheim, Savi, & Borgatto, 2012) that teaching students in a compressed, but effective and motivating way, is challenging. Thus, a course duration of 14 weeks, combined with the students' lack of experience, creates an important organizational challenge that could explain the students' scores for item F.16.

5.2. Learning outcomes (RQ2)

The results obtained in this study are similar to those obtained by other studies of teaching practices and student performance. This shows that the use of modern teaching practices, such as teamwork with defined roles ([P.1]), increases remarkably the reasoning ability of students (Bietenbeck, 2014; Harris & Sass, 2011; Méndez, 2015; Warin et al., 2011). Furthermore, as other authors have indicated (Epstein et al., 2010; Wolsey, 2008), providing students with formative and immediate feedback ([P.6]) helps them to identify their strengths and weaknesses, to revise their work, and to continuously refine their understanding. Thus, feedback can foster student engagement and improve the effectiveness of the learning process. In our approach, only the experimental group was provided with regular feedback through the developed ICT tools.

It is also worth mentioning that, although the use of virtual teams a priori could pose difficulties for project development (McGrath & Hollingshead, 1994), this was not the case within the experimental group, where teams included students from two universities in different locations. According to Haines (2014), the project members of successful virtual teams (1) should have clear, specific goals, and (2) should be encouraged or even required to communicate with each other. We were able to satisfy these requirements because the proposed framework is based on a well-structured methodology with tasks that were clearly defined ([P.1]) and specific procedures that explained how to communicate mandatory information through the ICT tools that had been developed ([P.3]).

5.3. Relationship between students' satisfaction and learning outcomes

This study reveals the following affective aspects as being the most relevant that appear to facilitate students' academic performance: (1) positive expectations for future professional development, (2) clear learning objectives that consistently relate to the course content, (3) positive feelings induced by instructors' support to resolve doubts, and (4) academic self-perception. These results are consistent with current learning theories that address how motivational and affective states influence student learning in higher education (Baeten, Doch, Struyven, Parmentier, & Vanderbruggen, 2015; Heikkilä, Lonka, Nieminen, & Niemivirta, 2012).

6. Conclusions

The purpose of this study was to analyze the effectiveness of a teaching program that integrates educational technology from the perspective of *situated learning* by students' performance and satisfaction. In particular, this work examines students' perceived levels of satisfaction and students' performance in a *virtual experience* that was created for project management learning.

6.1. Student satisfaction (RQ1)

The results of this research show that students are, in general, more satisfied with the new methodological approach that is proposed for teaching and learning project management than de conventional approach. Students perceive that the new methodology facilitates the intended learning by exhibiting high levels of satisfaction with (1) the relationship and consistency between the basic elements of the curriculum of the educational program (objectives and content) –item C.6 within the *reliability* dimension, and (2) the knowledge and skills acquired in project management during the learning process –items C.7 and C.8 within *reliability* dimension. Among these items, perhaps the most remarkable fact is that the perceived *degree of relationship and consistency* between the objectives and the contents of the educational program has a significant effect on the level of satisfaction. In this sense, it seems to be obvious that students must have clear objectives to achieve and, hence, specific content and conditions to lead learning in a particular direction. In this way, it is possible to avoid student dissatisfaction due to uncertainty when they do not have a clear understanding of what to learn and under what conditions.

Moreover, a higher level of perceived instructor support and guidance produces higher levels of satisfaction –item E.13 within *relationship* dimension. So, once again, the importance of the guiding and mentoring role that instructors assume is highlighted. That is, the adoption of student-centered teaching approaches does not diminish the role of the instructor as a mediator and facilitator in learning. Thus, paying attention to the challenge of improving the quality of teaching and learning processes in the new educational mode is necessary to strengthen the instructor's role. The teacher assumes an essentially strategic and mediator role in the cognitive processes that students activate by providing the assistance that is necessary to enhance self-regulated learning.

6.2. Student performance (RQ2)

In regard to the impact of the proposed learning activity on student learning and academic results, our findings suggest that adoption of the new methodology improves students' learning outcomes. Some positive and significant relationships between students' satisfaction and final marks were found. Thus, our study suggests that well-being and feelings of satisfaction influence positively academic performance, whereas feelings of confusion and dissatisfaction diminish motivation and impede the learning process. In fact, educational research demonstrates that cognitive and affective processes relate positively to learning (Baeten et al., 2015; Heikkilä et al., 2012; Lonka et al., 2008).

Educational research suggests that knowledge must be acquired in an *authentic context* and strongly emphasizes the importance of *social interaction* during the learning process. As a result, more effective learning of higher quality is obtained than with traditional teaching approaches (Bell et al., 2013; McLellan, 1996, pp. 5–17; Orgill, 2007, pp. 187–203). In this sense, this empirical study presents a new and more effective methodology that is based on PBL in an authentic context that offers opportunities for students to experience virtual teamwork, which can be used in many different environments. The teacher selects authentic situations or problems that are similar to those that students will encounter in the working world. Thus, the teacher provides students with opportunities to apply their knowledge in solving those problems and to develop contextualized skills in their professional environment (competence based learning). In addition, the technology used in this work facilitates the design (development) of an authentic context in which to develop the required skills.

7. Limitations and future work

Although this study was conducted for a particular context and discipline, our findings can provide a base of knowledge to support other proposals for the improvement of higher education. In any case, caution should be exercised in generalizing these results to other universities. Despite an important theoretical framework for the topic under study and the development of a rigorous research methodology, contextual and personal differences that characterize different universities can influence the results differently.

Because some aspects of students (e.g., personality, learning approaches, work experience, etc.) and the specific teaching context (e.g., institution procedures, resources, study conditions, etc.) could partially explain our results, further research should be conducted with a greater number of universities. Also, we consider it necessary to analyze other input variables that enable us to acquire further knowledge for continuous improvement in higher education. In this sense, some authors, such as Biggs (2005, p. 241), state that the level of students' satisfaction, their motivation, how they experience their learning environment and how they act, are largely determined by their approach to learning. That is, how students approach their learning ultimately determines how well they learn (Biggs, Kember, & Leung, 2001; Hernández Pina, Rosário, Cuesta Sáez de Tejada, Martínez Clares & Ruiz Lara, 2006). All of these aspects will be investigated in future work.

Acknowledgements

The authors wish to recognize the financial support of the “Vicerrectorado de Profesorado, Planificación e Innovación Docente” of the University of La Rioja, through the “Dirección Académica de Formación e Innovación Docente”.

References

Alba-Elías, F., González-Marcos, A., & Ordieres-Meré, J. (2014). An active project management framework for professional skills development. *International Journal of Engineering Education, 30*(5), 1242–1253.

Baeten, M., Doch, F., Struyven, K., Parmentier, E., & Vanderbruggen, A. (2015). Student-centred learning environments: An investigation into student teachers' instructional preferences and approaches to learning. *Learning Environments Research*. http://dx.doi.org/10.1007/s10984-015-9190-5.

Barron, S. (2005). Assessing project management learning – How can it make a difference?. In *2nd project management conference: Excellence in teaching, learning and assessment, Bournemouth* (pp. 15–16). September (2005).

Bell, S. (2010). Project-based learning for the 21st Century: Skills for the future. *The Clearing House, 83*, 39–43.

Bell, R. L., Maeng, J. L., & Binns, I. C. (2013). Learning in context: Technology integration in a teacher preparation program informed by situated learning theory. *Journal of Research in Science Teaching, 50*(3), 348–379.

Berggren, C., & Söderlund, J. (2008). Rethinking project management education: Social twists and knowledge co-production. *International Journal of Project Management, 26*, 286–296.

Bietenbeck, J. (2014). Teaching practices and cognitive skills. *Labour Economics, 30*, 143–153.

Biggs, J. (2005). *Calidad del aprendizaje universitario*. Madrid: Narcea.

Biggs, J., Kember, D., & Leung, D. Y. P. (2001). The revised two-factor study process questionnaire: R-SPQ-2F. *British Journal of Educational Psychology Education, 71*, 133–149.

Buttle, F. (1996). SERVQUAL: Review, critique, research agenda. *European Journal of marketing, 30*(1), 8–32.

Caulfield, C., Veal, D., & Maj, S. P. (2011). Teaching software engineering project management – A novel approach for software engineering programs. *Modern Applied Science, 5*(5), 87–104.

Chen, C. M., Lee, H. M., & Chen, Y. H. (2005). Personalized e-learning system using item response theory. *Computers & Education, 44*(3), 237–255.

Prague Communiqué. (2001). *Towards the European higher education Area, Prague*, 19.05.2001: Available from: http://www.enqa.eu/wp-content/uploads/2013/03/010519PRAGUE_COMMUNIQUE.pdf.

Duarte, D. L., & Snyder, N. T. (2006). *Mastering virtual teams: Strategies, tools and techniques that succeed* (3rd ed.). San Francisco, CA: Jossey-Bass.

Edelson, D. C., Gordin, D. N., & Pea, R. D. (1999). Addressing the challenges of inquiry based learning through technology and curriculum design. *Journal of the Learning Sciences, 8*(3–4), 391–450.

ENQA. (2010). Quality assurance and learning outcomes [online]. In *European Association for quality assurance in higher education*. Helsinki: Finland. Available from www.enqa.eu/indirme/papers-and-reports/workshop-and-seminar/WSR%2017%20-%20Final.pdf.

Epstein, M. L., Lazarus, A. D., Calvano, T. B., Matthews, K. A., Hendel, R. A., Epstein, B. B., et al. (2010). Immediate feedback assessment technique promotes learning and corrects inaccurate first responses. *The Psychological Record, 52*(2), 5.

ESU (European Students' Union). (2012). *Bologna with student eyes 2012 [online]*. Brussels: Education and Culture DG. Available from http://www.aic.lv/bolona/2010_12/Reports_2012/BWSE2012-online.pdf.

European Commission. (2005). *ECTS user's guide: European credit transfer and accumulation system and the diploma supplement*. Brussels: Directorate-General for Education and Culture.

European Commission. (2013). *Report to the European Commission on improving the quality of teaching and learning in Europe's higher education institutions*. Luxembourg: Publications Office of the European Union.

European Council. (2009). Council conclusions of 12 May 2009 on a strategic framework for European cooperation in education and training ('ET 2020'). *Official Journal of the European union* (2009/C 119/02).

Gikandi, J. W., Morrow, D., & Davis, N. E. (2011). Online formative assessment in higher education: A review of the literature. *Computers & Education, 57*(4), 2333–2351.

Ginns, P., Kitay, J., & Prosser, M. (2008). Developing conceptions of teaching and the scholarship of teaching through a graduate certificate in higher education. *The International Journal for Academic Development, 13*, 175–185.

Gómez, M. A., Rodríguez, G., & & Ibarra-Sáiz, M. S. (2013). COMPES: Autoinforme sobre las competencias básicas relacionadas con la evaluación de los estudiantes universitarios. *Estudios Sobre Educación, 24*, 197–224.

González-Marcos, A., Alba-Elías, F., & Ordieres-Meré, J. (2015). An analytical method for measuring competence in project management. *British Journal of Educational Technology* (in press).

González-Marcos, A., Alba-Elías, F., Ordieres-Meré, J., & Navaridas-Nalda, F. (2015). Competence assessment framework for project management learners and practitioners. *Communications in Computer and Information Science, 510*, 225–241.

Haines, R. (2014). Group development in virtual teams: An experimental reexamination. *Computers in Human Behavior, 39*, 213–222.

Harris, D. N., & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics, 95*(7–8), 798–812.

Heikkilä, A., Lonka, K., Nieminen, J., & Niemivirta, M. (2012). Relations between teacher students' approaches to learning, cognitive and attributional strategies, well-being, and study success. *Higher Education, 64*, 455–471.

Hernández Pina, F., Rosário, P., Cuesta Sáez de Tejada, J. D., Martínez Clares, P., & Ruiz Lara, E. (2006). Promoción del aprendizaje estratégico y competencias de aprendizaje en estudiantes de primero de universidad: Evaluación de una intervención. *Revista de Investigación Educativa, 24*(2), 615–631.

Hertel, G., Geister, S., & Konradt, U. (2005). Managing virtual teams: A review of current empirical research. *Human Resource Management Review, 15*, 69–95.

Hewagamage, C., & Hewagamage, K. (2011). Redesigned framework and approach for IT project management. *International Journal of Software Engineering and its Applications, 5*(3), 89–106.

Huber, G. L. (2008). Aprendizaje activo y metodologías educativas. *Revista de Educación, número extraordinario*, 59–81.

Hughes, J. (2012). The role of teacher knowledge and learning experiences in forming technology-integrated pedagogy. *Journal of Technology and Teacher Education*, 277–302.

IPMA. (2006). *ICB: IPMA Competence Baseline. Version 3.0*. International Project Management Association.

Johnson, S. D., Suriya, C., Won Yoon, S., Berrett, J., & Lafleur, J. (2002). Team development and group processes of virtual learning teams. *Computers & Education, 39*(4), 379–393.

Jonnaert, P. (2002). *Compétences et socioconstructivisme. Un cadre théorique*. Bruselas: De Boeck & Larcier.

Kloppenborg, T. J., & Baucus, M. S. (2004). Project management in local Nonprofit Organizations: Engaging students in problem based learning. *Journal of Management Education, 28*, 610–630.

Ku, H., Fulcher, R., & Xiang, W. (2011). Using computer software packages to enhance the teaching of engineering management science: Part 1-critical path networks. *Computer Applications in Engineering Education, 19*(1), 26–39.

Kuo, Y., Walker, A. E., Schroder, K. E. E., & Belland, B. R. (2014). Interaction, internet self-efficacy, and self-regulated learning as predictors of student satisfaction in online education courses. *The Internet and Higher Education, 20*(0), 35–50.

Lee, B. C., Yoon, J.-O., & Lee, I. (2009). Learners' acceptance of e-learning in South Korea: Theories and results. *Computers & Education, 53*(4), 1320–1329.

Li, Y., & Huang, J. (2013). Exploitative and exploratory learning in transactive memory systems and project performance. *Information & Management, 50*(6), 304–313.

Lonka, K., Parvaneh, S., Karlgren, K., Masiello, I., Nieminen, J., & Birgegard, G. (2008). MEDNORD–A tool for measuring medical students' well-being and study orientations. *Medical Teacher, 30*, 72–79.

Mama, M., & Hennessy, S. (2013). Developing a typology of teacher beliefs and practices concerning classroom use of ICT. *Computers & Education, 68*, 380–387.

Mayer, R. (2004). Should there be a three-strikes rule against pure discovery learning? The case for guided methods of instruction. *American Psychologist, 59*(1), 14–19.

McGrath, J. E., & Hollingshead, A. E. (1994). *Group interacting with technologies: Ideas, evidence, issues, and agenda*. Thousand Oaks, CA: Sage.

McLellan, H. (1996). Situated learning: Multiple perspectives. In H. McLellan (Ed.), *Situated learning perspectives* (pp. 5–17). New Jersey: Educational Technology Publications.

Méndez, I. (2015). *Prácticas docentes y rendimiento estudiantil. Evidencia a partir de TALIS 2013 y PISA 2012*. Madrid: INEE-Fundación Santillana.

Navaridas, F. (2004). *Estrategias didácticas en el aula universitaria*. Logroño: Universidad de La Rioja.

Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in higher education, 31*(2), 199–218.

Niemeyer, B. (2006). El aprendizaje situado: Una oportunidad para escapar del enfoque del déficit. *Revista de Educación, 341*, 99–121.

Nooriafshar, M. (2013). The effectiveness of a lifecycle approach to learning project management. *The European Journal of Social & Behavioural Sciences, 4*(1), 836–847.

Nunnally, J. C. (1978). *Psychometric theory* (2nd ed.). New York: McGraw-Hill.

O'Dowd, R. (2013). Telecollaborative networks in university higher education: Overcoming barriers to integration. *The Internet and Higher Education, 18*(0), 47–53.

Office of Government Commerce. (2009). *Managing successful projects with Prince2™*. Office of Government Commerce.

Ojiako, U., Ashleigh, M., Chipulu, M., & Maguire, S. (2011). Learning and teaching challenges in project management. *International Journal of Project Management, 29*, 268–278.

Orgill, M. (2007). Situated cognition. In G. M. Bodner, & M. Orgill (Eds.), *Theoretical frameworks for research in chemistry/science education*. Upper Saddle River, NJ: Prentice Hall.

Ozkan, S., & Koseler, R. (2009). Multi-dimensional students' evaluation of e-learning systems in the higher education context: An empirical investigation. *Computers & Education, 53*(4), 1285–1296.

Paechter, M., Maier, B., & Macher, D. (2010). Students' expectations of, and experiences in e-learning: Their relation to learning achievements and course satisfaction. *Computers & Education, 54*(1), 222–229.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing, 49*(4), 41–50.

Parasuraman, A., Zeithaml, V. A., & Berry, L. L. (1988). SERVQUAL: A multiple-item scale for measuring consumer perceptions of service quality. *Journal of Retailing, 64*(1), 12–40.

Peñarroja, V., Orengo, V., Zornoza, A., Sánchez, J., & Ripoll, P. (2015). How team feedback and team trust influence information processing and learning in virtual teams: A moderated mediation model. *Computers in Human Behavior, 48*, 9–16.

Pérez-Sanagustín, M., Muñoz-Merino, P. J., Alario-Hoyos, C., Soldani, X., & Delgado Kloos, C. (2015). Lessons learned from the design of situated learning environments to support collaborative knowledge construction. *Computers & Education, 87*, 70–82.

PMI. (2008). *A Guide to the project management Body of knowledge (PMBOK guide)* (4th ed.). Project Management Institute.

Qureshi, T. M., Warraich, A. S., & Hijazi, S. T. (2009). Significance of project management performance assessment (PMPA) model. *International Journal of Project Management, 27*(4), 378–388.

Roger, A. (2008). Excellence in teaching and learning project management. *International Journal of Project Management, 26*(3), 221–222.

Romano, J., Kromrey, J. D., Coraggio, J., & Skowronek, J. (2006). Appropriate statistics for ordinal level data: Should we really be using t-test and Cohen's d for evaluating group differences on the NSSE and other surveys?. In *Annual meeting of the Florida Association of Institutional Research*.

van Rooij, S. W. (2009). Scaffolding project-based learning with the project management body of knowledge (PMBOK®). *Computers & Education, 52*(1), 210–219.

Salas-Morera, L., Arauzo-Azofra, A., García-Hernández, L., Palomo-Romero, J. M., & Hervás-Martínez, C. (2013). PpcProject: An educational tool for software project management. *Computers & Education, 69*, 181–218.

Santos, O. C., & Boticario, J. G. (2015). Practical guidelines for designing and evaluating educationally oriented recommendations. *Computers & Education, 81*, 354–374.

Schön, D. (1983). *The reflective practitioner: How professionals think in action*. New York: Basic Books.

Seidel, T. (2012). Implementing competence assessment in university education. A comment on using the Collegiate Learning Assessment as a prototype. *Empirical Research in Vocational Education and Training, 4*(1), 91–94.

Smith, G. (2007). How does student performance on formative assessments relate to learning assessed by exams? *Journal of College Science Teaching, 36*(7), 28–34.

Solomon, G. (2003). Project-based learning: A primer. *Technology & Learning, 23*(6), 20.

Stodnick, M., & Rogers, P. (2008). Using SERVQUAL to measure the quality of the classroom experience. *Decision Sciences Journal of Innovative Education, 6*(1), 115–133.

Thomas, J., & Mengel, T. (2008). Preparing project managers to deal with complexity—Advanced project management education. *International Journal of Project Management, 26*(3), 304.

Turley, F. (2010). *The Prince2 practitioner training manual*. Version 1.0h. [online] Available from [21/06/2013] http://bblog.ch/pdf/prince2/The-PRINCE2-Training-Manual.pdf.

Turner, J. R., Keegan, A., & Crawford, L. (2000). Learning by experience in the project-based organization. In *Project management research at the turn of the millenium: Proceedings of PMI research conference* (pp. 21–24). Paris, France: Sylva (NC): Project Management Institute, 445–456.

Valentín, A., Mateos, P. M., González-Tablas, M. M., Pérez, L., López, E., & García, I. (2013). Motivation and learning strategies in the use of ICTs among university students. *Computers & Education, 61*, 52–58.

Von Wangenheim, C. G., Savi, R., & Borgatto, A. F. (2012). Deliver! - An educational game for teaching earned value management in computing courses. *Information and Software Technology, 54*(3), 286–298.

Wang, Y. S., Wang, H. Y., & Shee, D. Y. (2007). Measuring e-learning systems success in an organizational context: Scale development and validation. *Computers in Human Behavior, 23*(1), 1792–1808.

Warin, B., Kolski, C., & Sagar, M. (2011). Framework for the evolution of acquiring knowledge modules to integrate the acquisition of high-level cognitive skills and professional competencies: Principles and case studies. *Computers & Education, 57*(2), 1595–1614.

Wolsey, T. (2008). Efficacy of instructor feedback on written work in an online program. *International Journal on E-Learning, 7*(2), 311–329.

Yarmohammadian, M. H., Mozaffary, M., & Esfahani, S. S. (2011). Evaluation of quality of education in higher education based on academic quality improvement program (AQIP) model. *Procedia-Social and Behavioral Sciences, 15*, 2917–2922.

Zabalza, M. A. (2011). Metodología docente. Revista de Docencia Universitaria. REDU. Monográfico: El espacio europeo de educación superior. Available from: *¿Hacia dónde va la Universidad Europea?, 9*(3), 75–98 [08/10/2014] http://redaberta.usc.es/redu.

Zhang, L., He, J., & Zhang, X. (2012). The project management maturity model and application based on Prince2. *Procedia Engineering, 29*, 3691–3697.

Zhang, D., Zhou, L., Briggs, R. O., & Nunamaker, J. F., Jr. (2006). Instructional video in e-learning: Assessing the impact of interactive video on learning effectiveness. *Information & Management, 43*(1), 15–27.