Accepted Manuscript

Collaborative agile learning in online environments: Strategies for improving team regulation and project management

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PII: S0360-1315(17)30212-9

DOI: 10.1016/j.compedu.2017.09.008

Reference: CAE 3241

To appear in: *Computers & Education*

Received Date: 8 November 2016

Revised Date: 12 September 2017

Accepted Date: 13 September 2017

Please cite this article as: Noguera I., Guerrero-Roldán A.-E. & Masó R., Collaborative agile learning in online environments: Strategies for improving team regulation and project management, *Computers & Education* (2017), doi: 10.1016/j.compedu.2017.09.008.

Collaborative agile learning in online environments: strategies for improving team regulation and project management

ABSTRACT

Unsatisfactory prior experiences in collaborative learning influence students' predisposition towards team-based learning activities. Incorporating strategies for helping teams to effectively regulate group work and enhance planning processes may result in an increase in students' engagement with learning activities and collaborative processes. Taking into account the benefits of the agile method for teamwork organisation, this study sought to analyse the usefulness of agile strategies for team regulation and project management in online higher education. An iterative process of course redesign was conducted in the context of an undergraduate project-based learning course during two consecutive semesters. The new design was piloted and evaluated based on the students' and teacher's views and the learning outcomes. A total of 114 students were surveyed about their satisfaction with the course and their perception of the usefulness of the method. Two interviews were conducted to collect the teacher's opinions. The results of the study indicate that agile strategies are useful for improving students' online project management and collaboration. Nevertheless, no significant impact has been observed in students' satisfaction nor in the overall learning outcomes.

Keywords: cooperative/collaborative learning, teaching/learning strategies, distance education and telelearning, post-secondary education

1. Introduction

Teamwork is one of the key competencies that students must acquire to meet the needs and skills of the labour market, as recognised by the European Higher Education Area (EHEA). The capacity to work in groups is of particular importance, as many jobs are becoming too multifarious for just one person to effectively complete. Research demonstrates that learning in collaboration may increment students' motivation, persistence, and efficiency due to the exchange of ideas (Liaw, Chen & Huang, 2008; Laux, Luse & Mennecke, 2016). However, just proposing group working does not guarantee effective collaboration (Johnson & Johnson, 2004). Students need to learn how to collaborate effectively and how to self-regulate their collaboration (Tseng & Yeh, 2013; Miller & Hadwin, 2015).

Effective collaboration transcends the notion of grouping students together to learn something and requires that students handle complex skills such as commitment, time management, negotiation, adopting different roles and responsibilities, planning, and taking into account other views (Noguera, 2013). Teams may encounter many challenges for organising teamwork that can be managed through appropriate strategies in a process of socially shared regulation of learning (SSRL), in which behaviours, motivation, and emotions are collectively regulated (Malmberg, Järvelä, Järvenoja & Panadero, 2015). Nevertheless, learners frequently lack the regulatory skills required for complex collaborative tasks and often fail to interact productively in groups (Miller & Hadwin, 2015).

Collaborative learning is highly demanding, and it becomes even more challenging when all collaboration occurs online. Even so, computer-supported collaborative learning (CSCL) has become increasingly widespread. Research evidences that students may feel frustrated when performing online collaborative learning activities due to communication difficulties and an imbalanced commitment among team members (Capdeferro & Romero, 2012). However, social interaction is considered to be one of the critical elements in CSCL (Abedin, Daneshgar & D'Ambra, 2011; Lin, Hou, Wang & Chang, 2013), and research suggests that trust among team members is one of the variables that clearly affects virtual teams'

success (Luse, McElroy, Townsend & DeMarie, 2013). However, as Peñarroja, Orengo, Zornoza and Hernández (2013) affirmed, trust among team members is hard to gain in online learning environments.

Bearing in mind the factors that influence online collaboration and teamwork satisfaction, a study conducted by Tseng, Wang, Ku and Sun (2009) revealed that trust among classmates and organisation practices contribute to students' satisfaction in online collaborative processes. As demonstrated by Fransen, Kirschner and Erkens (2011), the lack of trust in a team increments the effort spent in protecting, checking and monitoring other members and their behaviours. Thus, by incorporating trust-building strategies, the students' achievement and attitudes toward online cooperative learning may improve (Nam, 2014). Individual accountability, familiarity with other team members, commitment, and team cohesion are significant variables in building trust between team members (Tseng & Yeh, 2013). Furthermore, team dynamics and familiarity (i.e., commitment, frequent communication) and instructor support (i.e., encouraging learners, well-defined and well-organised instruction) also impact teamwork satisfaction (Ku, Tseng & Akarasriworn, 2013).

This review of collaborative online learning suggests that various strategies are needed to help groups improve group dynamics, enhance the planning processes, and organise group work to effectively learn in collaboration and increase teamwork satisfaction. The agile method is a well-known project management approach that aims to regulate teamwork processes. It differs from traditional approaches to project management as it is characterised by a high adaptability to change. Thus, there is a continuous decision-making process based on oncoming needs and demands and there are regular iterative reviews during which changes are incorporated on the fly instead of following a pre-established structured process. Furthermore, the agile method goes beyond the hierarchical top-down organisation in traditional project management and gives teams a predominant role by promoting an efficient distribution of roles and responsibilities, encouraging frequent communication between team members and customers, and splitting the work into tasks and regular deliveries. These characteristics have positively impacted project management and teamwork regulation in software development.

Taking into account previous agile-based learning experiences, we have analysed the potential of the agile method for improving collaborative learning in regard to team regulation, project management, and students' satisfaction. This study contributes to the field of collaborative learning by introducing new strategies inspired by the agile method for enhancing team dynamics in project-based learning. Thus, various agile methods have been explored and their transference to the educational context has been investigated. As a result, a proposal for introducing the agile method into the online university context for collaborative project management has been piloted and analysed.

The main research questions that have oriented the study are:

RQ1. What are the students' and teacher's perceptions of the usefulness of agile strategies for team regulation in collaborative project-based learning?

RQ2. What are the students' and teacher's perceptions of the usefulness of agile strategies for project management in collaborative project-based learning?

RQ3. Does a methodology that is based on agile strategies and that offers opportunities for team regulation and project management improve the overall level of students' satisfaction with the course?

RQ4. Does the use of a methodology based on collaborative project management significantly improve students' academic performance?

2. Theoretical framework

2.1 Advantages of the agile method

During the 1980s, the traditional sequential methods (e.g., the waterfall method) used for software development were criticised and reconsidered. The main criticism stemmed from the evidence that these processes do not permit the incorporation of changes based on customers' requirements during the project and, consequently, the final products often do not meet the clients' needs. In response to this issue, the

software development working methods have evolved towards iterative processes such as the agile method.

The agile method is characterised by teamwork, frequent communication, adaptation to change and decision-making in ongoing projects. The *Manifesto for Agile software development* (Fowler & Highsmith, 2001) collects the fundamental principles of these methodologies:

- Individuals and interaction over processes and tools. The communication that occurs in teamwork and continuous customer feedback takes precedence over the interactions established by predefined processes and tools.
- Working software over comprehensive documentation. The documentation for justifying proper software functioning is replaced by constant testing to prove that the software works correctly.
- Customer collaboration over contract negotiation. It is assumed that the customer's needs evolve and that developers must collaborate with clients and evolve with them.
- Responding to change over following a plan. Continuous feedback is provided during the project and changes are incorporated that continuously adapt the product to the customer's needs.

Generally speaking, the agile method introduces substantial improvements to the teamwork within a project. This includes a more efficient and definite distribution of roles and responsibilities, task-based work, workflow visualisation, frequent communication between team members and clients, and iterative reviews and improvement processes. Several agile methods have flourished with distinct strategies for organising group work, such as the Scrum and Kanban methods. For example, the Scrum method proposes a rotation of roles, partial deliveries of work (sprints), frequent task evaluation, regular meetings, organisation of work in task blocks, and responsibility shared between team members. Most of these strategies are likewise followed by the Kanban method, which puts an emphasis on the graphical representation of work and frequent delivery and prioritisation of tasks (Kniberg, 2009).

Agile project management has emerged based on the agile methodologies. Agile project management refers to the implementation of agile strategies into any area of project management that aims for effective teamwork processes. In agile project management, strategies and characteristics from diverse agile methodologies are combined. The observed benefits of agile project management include an increase in the quality of products, manageable expectations, greater customer satisfaction, higher performing teams, improved visibility of progress, as well as predictability, transparency, and confidence (Barnes, 2015).

As a result of the positive changes in work dynamics for project development presented by these methodologies, the agile principles are being progressively incorporated into diverse professional and academic contexts.

2.2 Incorporation of agile project management into the educational context

The *Agile Manifesto in Higher Education* (Kamat, 2012) defines four guiding principles for extending the agile principles into the educational context: a) teachers and students over administration and infrastructure, b) competence and collaboration over compliance and competition, c) employability and marketability over syllabus and marks, and d) attitude and learning skills over aptitude and degree. In brief, the aim of agile learning is to receive continuous feedback, learn from previous iterations and improve on future iterations (Kamat, 2012).

The agile method has been increasingly incorporated in Computer Science courses in higher education. Teachers are promoting agile work practices, especially those based on Scrum, and believe that familiarising students with agile methods is an effective strategy for preparing them to face challenges in real job situations (Scott, Rodríguez, Soria & Campo, 2014). The agile methods are being incorporated into these courses both as content and as the working method for students. The introduction of these strategies into knowledge areas other than Computer Science for learning purposes is attracting the interest of some authors because of the leap they represent in collaborative and organisational processes. The process through which students learn following the agile principles is known as agile learning.

Agile learning implies that learners create content and develop skills alongside teachers in a collaborative yet competitive environment mediated by technology (Royle & Nikolic, 2013). The role of the teacher is centred on facilitation and project direction from an informed perspective. Learners become self-directed, team-oriented, and individually resilient lifelong learners. Table 1 summarises the main features that characterise the agile approach in educational contexts.

Table 1.
Features of the agile approach (Adapted from Royle & Nikolic, 2013).

	Features
General	Ownership of the work. Collaborative approach constructed under reflective planning and review processes. Self-management framework and intrinsic motivation for task definition, completion, and evaluation. Problem-based content. Emphasis on self-help within the team for achieving the tasks, learning about themselves, and developing skills. Various controls on the quality of outputs and assessment criteria. Negotiation of the definition of 'done' for a completed project.
Team	Is the main driver and controller of the work. The individual is important within the team. Knowledge is constructed, the team decides how to learn and members achieve tasks collaboratively. Solves issues and organises team members to achieve the tasks. The number of members within a team depends on the number of functionalities, tasks, and roles.
Teacher	Takes the role of team facilitator or Project Owner. Has a more collaborative rather than leading role. Takes part in the review of tasks and acts as a mentor, coach, and guide. Reflects on how skills can be acquired through real or simulated activities that are negotiated by learners.

The above-mentioned premises have been transferred to the educational context in the *eduScrum guide*.[1] In this approach, an eduScrum Team is composed of a Product Owner (the teacher who determines what needs to be learned, monitors the process, and evaluates students), the Student Team (a self-organised, responsible and multidisciplinary team that delivers learning results iteratively and incrementally), and an eduScrum Master (a coaching leader chosen by the Product Owner or the class who helps the team perform optimally). Table 2 summarises the characteristics associated with each role.

Table 2.
eduScrum team roles and characteristics (adapted from Delhij & van Solingen, 2013).

Role	Tasks
Product Owner	Determines what needs to be learned. Monitors and improves the quality of learning products. Evaluates and judges the learning products. Ensures that eduScrum is understood and correctly executed. Is responsible for the propagation of the eduScrum philosophy.
Student Team (four or fewer students)	Is self-organised and multi-disciplinary. Decides how to best accomplish their work. Encourages cross-team cooperation. Is designed for optimal autonomy, collaboration, flexibility, creativity, motivation, and productivity. Delivers learning results iteratively and incrementally.

[1] Guide available online at the website: http://eduscrum.nl/en/

	Maximises opportunities for feedback and adjustment. Is responsible for performing the work.
eduScrum Master (One of the four students)	Is a coaching leader chosen by the Product Owner or by the class. Helps the team perform optimally. Takes on more responsibilities from the Product Owner as more experience is gained. Chooses team members with complementary skills. Is responsible for the Scrum board and ensuring that it is available and up-to-date. Supports the Product Owner and the Student Team. Facilitates eduScrum events when needed. Ensures correct execution of eduScrum. Facilitates cross-team collaboration.

The work of the eduScrum team is organised into events and sprints. The events are time-boxed with a maximum duration and are designed to enable critical transparency and inspection. The sprints are the containers of all events, are coherently organised to achieve the learning goals, and usually last two months or less. Each sprint consists of: a) a planning meeting at the beginning of the sprint (including team formation, learning goals and work planning); b) stand-ups at the beginning of every class (five-minute time-boxed events for synchronising activities and making plans until the next meeting); c) performing assignments and tasks within a sprint; d) review at the end of the sprint to display what the members have learned in the last sprint; e) a sprint retrospective after the sprint review to create a plan for improvement and prepare for the upcoming sprint assignment; and f) personal reflection.

The *eduScrum guide* is a valuable approach to agile learning as it describes how the agile method can be transferred to face-to-face secondary education in practice. This guide transcends the common educational approach to the agile method as a subject of study and exemplifies how it can be implemented to improve group dynamics and team organisation. However, taking into account the aim of this paper, some adjustments are needed to adapt agile strategies to the online university context, in which there are no class sessions and no regular synchronous meetings, for example. Therefore, by incorporating and accommodating some agile strategies into online, collaborative, project-based learning (e.g., regular meetings, work organised by tasks and cycles, distribution of tasks by roles, visualisation of task flow), it is expected that communication among team members will be more fluent, work will be more effectively planned and developed, and responsibilities will be transparently distributed among students. In summary, it is envisaged that the students' experience with collaborative learning will be enhanced and that they will ultimately be more satisfied with the course.

The results of this paper may contribute to fill in the gaps in the literature regarding the benefits of the agile method for improving teamwork and planning procedures in collaborative project-based learning in online higher education. The next section describes the process conducted in our study for adapting the agile method to online higher education.

3. Research Method

3.1 Design

The design-based research approach has been applied to cyclically test and evaluate a course design. This method is characterised by the implementation of iterative processes in which solutions are given to complex and practical educational problems (McKenney & Reeves, 2012). Design-based research aims to transfer educational research into real formative contexts to improve educational practices and generate new knowledge (Anderson & Shattuck, 2012; Sandoval, 2013). The study presented in this paper has tested the adaptation of agile principles to online higher education for improving the learning process and generating new theories of online collaborative learning. Fig. 1 illustrates the stages that have oriented the research process, namely: analysis, design, implementation, and evaluation.

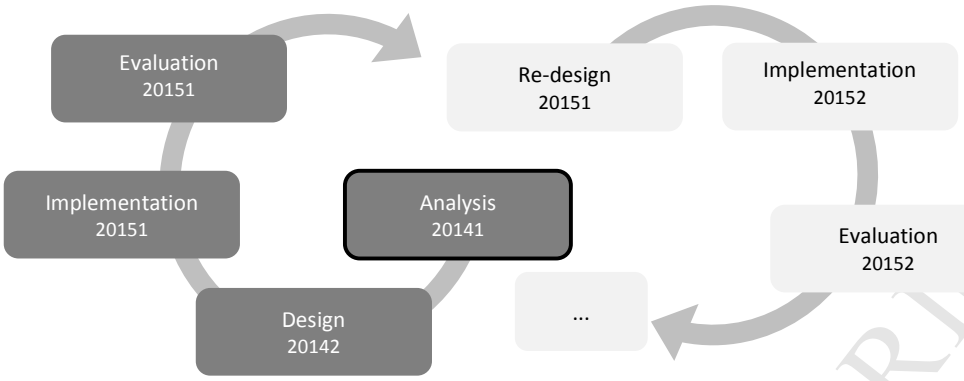

Fig. 1.
Research phases.

During the analysis process (fall semester, academic year 2014/2015), the coordinating professor[2] (who is also one of the researchers in this study) and the course instructor, from now on 'teacher', observed and took note of all issues concerning the students' performance in the course's collaborative agile project. Throughout the spring semester of the academic year 2014/2015, the design process began between the teacher and the researchers. Three face-to-face and two virtual meetings were conducted for designing the new learning scenario. A collaborative writing tool (Google Drive) and file-sharing tool (Dropbox) were also used for collectively developing new course documentation. Once the new scenario was defined, the implementation process started during the fall and spring semesters of the academic year 2015/2016. The new course design was tested in a course during two consecutive semesters. During the course, the teacher took notes and discussed the implementation of the design with the researchers. After each iteration, the design was evaluated based on the teacher's notes and opinions (collected through two interviews) and the students' opinions (collected through two surveys conducted at the end of both semesters). Based on the evaluation, minor changes were applied to the design that were merely focused on giving more and clearer guidelines to students.

3.2 Setting and participants

The participants in this study were undergraduate students from the Multimedia degree who were enrolled in the course entitled 'Collaborative Learning in Virtual Environments' at the online Open University of Catalonia (UOC). The pilot was conducted in two consecutive semesters during the 2015/2016 academic year using different student samples with equal conditions (i.e., teacher, course design, assessment criteria). The selected course is mandatory in all Computer Science, Multimedia, and Telecommunication bachelor's degrees. The primary purpose of this course is to promote the acquisition of 'online collaborative work' and the 'use of ICT in learning and professional environments' competencies. It is a project-based learning course in which students are encouraged to build a digital project in small groups while progressively performing learning activities. The project consists of developing a report on the topic 'Engineering and ICT: opportunities and specialisation fields for future engineers'. Students must select a theme, search for information, and develop an informative report on the state of the art. This project must be developed in teams within a wiki. It is divided into three phases, each one corresponding to the delivery of one assessment activity. The first phase, Preparation, focuses on establishing group agreements and planning the work (Activity 1). The second phase, Development, aims to progressively develop the project (Activity 2), while the last phase, Closure and Dissemination,

[2] There are two roles involved in UOC courses. The *coordinating professor* designs courses, monitors course instructors, and validates the students' assessment. The *course instructor* monitors students, provides feedback, and assesses the students.

concentrates on delivering the project (Activity 3). At the end of the course, each group creates a presentation of the project and discusses it with the entire class (Activity 4).

Fifty-eight students joined the course during the fall semester (20151) of the 2015/2016 academic year (46 male, 12 female; mean age = 29 years), and fifty-six students were enrolled in the course during the spring semester (20152) of the 2015/2016 academic year (47 male, 9 female; mean age = 32 years). The total sample consisted of 114 students, the majority of them male (82%) and with a mean age of 31 years. Two researchers and one teacher participated in the pilot during the two semesters (the teacher is male, in the 40-50 age group).

The students were divided into 10-12 project teams, each of which consisted of four project members. Students formed the groups on the basis of personal criteria. The selected topics were, for example: apps, 3D printing, virtual reality, autonomous vehicles, video games, and artificial intelligence.

3.3 Research instruments

3.3.1 Student satisfaction survey

The students' course satisfaction was determined by an institutional survey consisting of 26 items divided into four categories: overall course satisfaction, course instructor, teaching-learning resources, and type of assessment (a detailed list of items can be found in Appendix 1). The survey consisted in statements for responses on a Likert scale of 1–5 (labelled from 'strongly disagree' to 'strongly agree'). This survey is given at the end of each course. For the purpose of this article, data have been gathered from four consecutive semesters (20141-20152) in order to compare the satisfaction between the semesters during which the agile method was not implemented (20141, 20142) and the semesters during which the agile method was piloted (20151, 20152). This instrument has been used to respond to the third research question regarding students' satisfaction.

3.3.2 Complementary survey on agile strategies

The students' perception of the usefulness of the agile method was obtained through a complementary survey comprising 13 items covering three categories: agile strategies for team regulation (e.g., meetings, roles), agile strategies for project management (e.g., work cycles, task lists), and acquired knowledge of the agile method. One open item let respondents add any further comments they wished (a detailed list of items can be found in Appendix 2). The classification method required respondents to sort the statements on a four-point scale ranging from 'not at all' to 'a lot'. This survey was given at the end of the 20151 and 20152 semesters. This instrument was used to respond to the first and second research questions regarding the usefulness of the agile strategies for improving collaborative project management and to complement the third research question concerning students' satisfaction with the course.

3.3.3 Teacher interviews

The teacher's perspective was collected through two semi-structured interviews consisting of 6-9 questions regarding his experience in designing and guiding an agile-based course (a detailed list of questions can be found in Appendix 3). The first interview was conducted at the end of the fall semester 20151, and the second at the end of the spring semester 20152. The results of the interviews have been used to respond to all research questions.

3.3.4 Marks

The marks from the semesters during which the agile method was implemented and the marks from the two previous semesters were contrasted in order to explore whether or not there were significant differences in the learning outcomes. The data were used to answer the fourth research question. A

student's final mark in the course was determined by a weighted average of the marks that he or she received for each assessment activity. Grades ranged from A (Excellent) to D (Fail).

3.4 Data collection process

Students completed the surveys anonymously online. The institutional survey was given at the end of both semesters during the fourth and fifth week of January 2016, and the third and fourth week of June 2016. The complementary survey was given at the end of each semester but prior to the institutional survey during the second and third week of January 2016, and the second and third week of June 2016. The first teacher interview was conducted during the second week of January 2016, and the second one during the first week of June 2016. Both interviews lasted 45 minutes. The sessions were launched online through Google Hangouts, recorded, and later coded using the *Atlas.ti v7.5* software.

3.5 Data analysis

The four research questions were answered by examining the data from the institutional survey, the complementary survey, the interviews and the students' marks. A deductive approach was implemented for data analysis. The research questions were used to group the data and detect the main findings. As for the institutional survey, some calculations could not be conducted, as the authors of this paper did not have access to the original database. Data were collected on the basis of the reports that teachers received from the university. A descriptive analysis was conducted to analyse the quantitative data gathered from the complementary survey. Responses to open questions were coded. There was a reasonable response rate of 48% of students answering the complementary survey during the semester 20151, and a response rate of 19% was obtained for the institutional survey. In the 20152 semester, there was a response rate of 41% for the complementary survey and 12% of students completed the institutional survey. The number of responses received in the surveys was not sufficient for generalising and may not be representative of the entire population. Nevertheless, the data obtained from these surveys have been triangulated with the results from the teacher's interviews and the learning outcomes. The findings presented below seek to describe the specific case of the students and teachers who participated in the pilot.

A thematic analysis was conducted to code and analyse the data from the interviews. Codes from the first interview focused on aspects related to the specific strategies implemented, teamwork, and project management. Codes from the second interview were more general and were comprised of topics referring to satisfaction, quality, collaboration, project management and design. A descriptive analysis was conducted to compare and analyse the marks from courses in which the agile method was implemented and the marks from previous semesters.

4. Course redesign

4.1 Changes in course design

The analysis process served to identify the main issues in the course design. Although it was detected that project-based learning was quite appreciated by students in this course, negative reactions towards collaborative learning and inefficient collaborative practices among students were observed. This included comments on a lack of team responsibility, lack of commitment to the team and the task, inefficient planning, and a lack of reflection on and improvement to the ongoing project. Some strategies were incorporated into the project-based methodology in order to improve the efficiency of collaborative learning processes and were mainly derived from the Scrum and Kanban methods. The strategies were as follows: a) work cycles (WC), task lists and a tool for visualising the workflow were incorporated into the

project in order to help students plan the project efficiently; b) new roles were proposed with detailed responsibilities for dealing with the lack of team responsibility and commitment; c) reviews and reflections were defined at the end of each cycle and during the project through monitoring meetings and end-of-WC meetings to overcome the lack of reflection and inefficient communication. Table 3 describes the differences between the previous course approach to project-based learning and the experimental proposal for agile project management that was implemented, as well as the specific indications given to students for adapting agile strategies to their work processes.

Table 3.
Differences between project-based and agile project management learning, and guidelines for adopting the agile method.

Core elements	Project-based learning	Agile project management	Guidelines for agile project management
Phases	Linear and progressive	Incremental, iterative, adaptive	Organised into four interdependent phases in which the complexity grows incrementally. A second phase organised into five iterative WC. The project is constantly adapted to needs.
Roles	Reporter, resource manager, recorder, timekeeper	Project Manager, WC Manager + project-based roles	1 Project Manager + 1 WC Manager (rotational). Project Manager: monitors the project, maintains the coherence among WCs and tasks, updates the project tasks list, ensures short and productive end-of-WC meetings, facilitates and monitors team collaboration, solves issues in project. WC Manager: coordinates all tasks within a WC, creates agendas for meetings, makes meetings dynamic, solves WC issues. All students: responsible for assigned tasks and other roles agreed upon.
Decision making	Initial agreements on communication, organisation, motivation, and collaboration	Project-based initial agreements	Contains: a general list of tasks, distribution of roles and responsibilities, agreements (communication, organisation, motivation, collaboration).
Time management	Time distributed between predefined stages and promotion of regular meetings	Organised in WC	Each WC lasts 1 week. Time defined per each task. Meetings last 10-15 minutes.
Tasks	Initial work plan (adaptable) determining tasks and time dedication (calendar)	General list of tasks and a list of tasks per WC Tasks are reviewed during the process	1 general task list at the beginning of the course. 1 task list per WC. List of tasks contain: member responsible, time dedication, value (low, medium, high), indicators, deadlines, status (in process, done, pending). Trello tool for visualising tasks, member responsible and status. Task length less than 1 WC. Once the WC is completed, the status of tasks must change in the task list to complete. Pending and new tasks must be incorporated into the following WC.
Monitoring	Regular meetings and continuous communication during the project	Regular short mandatory meetings during each WC	Two monitoring meetings per WC. Agenda for each meeting. Minutes containing: status of tasks, deviations, agreements. All students may inform about work done, future work and issues in each meeting.

Review	At the end of the project, individually and in a group	At the end of each WC, reflecting on the teamwork process and the learning products	1 meeting at the end of each WC Agenda for each meeting. Minutes containing: topics of discussion, agreements, deviations and decisions.

The strategies for agile project management were mainly incorporated in the first two phases of the project. During the Preparation phase, students distributed roles and responsibilities, planned the tasks and created a document of agreement. Two mandatory agile-based roles (Project Manager and WC Manager) were incorporated into the traditional project-based learning roles (reporter, resource manager, timekeeper, recorder). The WC Manager role is rotational, while the role of the Project Manager is desirably maintained during the whole project. Every student is responsible for the execution of the project and the whole group shares the responsibility for any task. A document of agreement that incorporates a chronological distribution of tasks (general task list for the entire project), the roles and responsibilities, and project-based agreements (communication, organisation, collaboration) is required.

Through the Development phase, the work process was divided into five WCs that lasted one week each. Students were encouraged to create a list of tasks per each WC (WC backlog) and to use the Trello [3] tool for managing and scheduling them. The development of the project was reviewed iteratively through regular meetings during and at the end of WCs. Any deviation could be readdressed in a short period of time with the consent of all participants. The planning was continuously adapted to ensure on-time delivery and a high-quality product. From the teacher's point of view, continuous formative e-feedback was provided during and at the end of each WC. The teacher acted as a supervisor and facilitator, helping students to improve their learning process iteratively through the development of the digital project. Fig. 2 illustrates the teaching-learning process that resulted from the new course design regarding the actions that the students and teacher performed during the first two phases of the project. Furthermore, in order to provide real examples of such actions, Fig. 3 shows some screenshots of the real work performed by teams: a list of tasks created in the Trello tool (1), a list of tasks created in Excel format (2), a document of agreement (3), the minutes of a monitoring meeting (4), the minutes of an end-of-WC meeting (5), and the final version of two projects in wiki format (6, 7).

[3] https://trello.com/

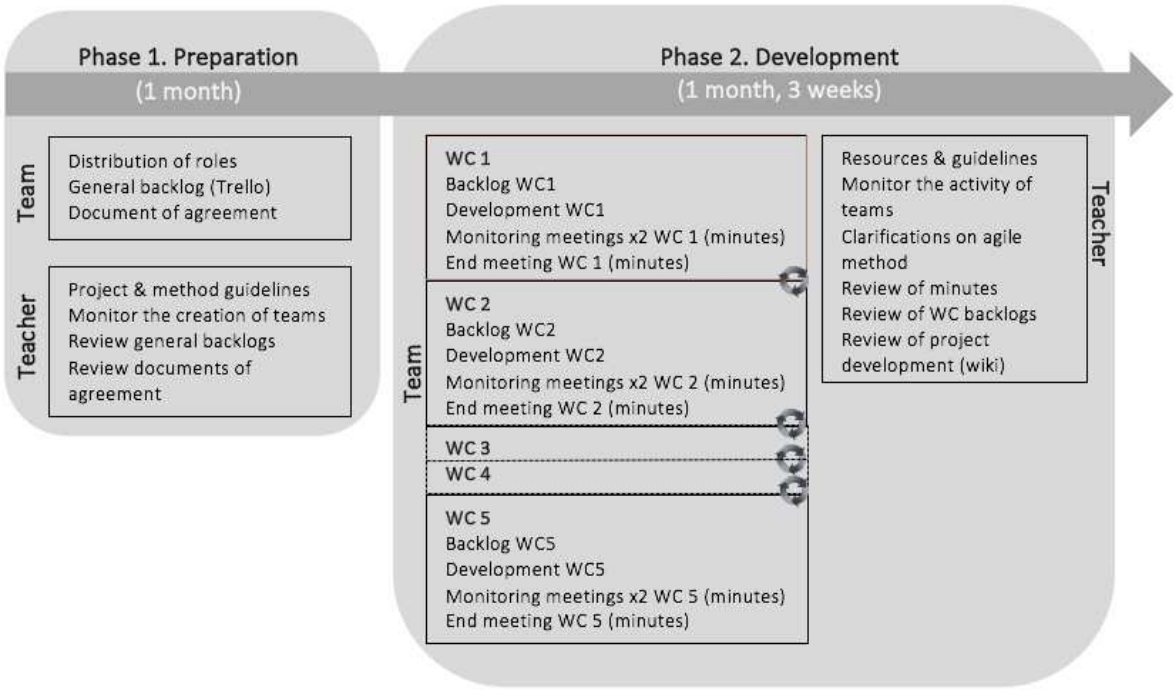

Fig. 2.
Representation of the teaching-learning process within collaborative agile projects.

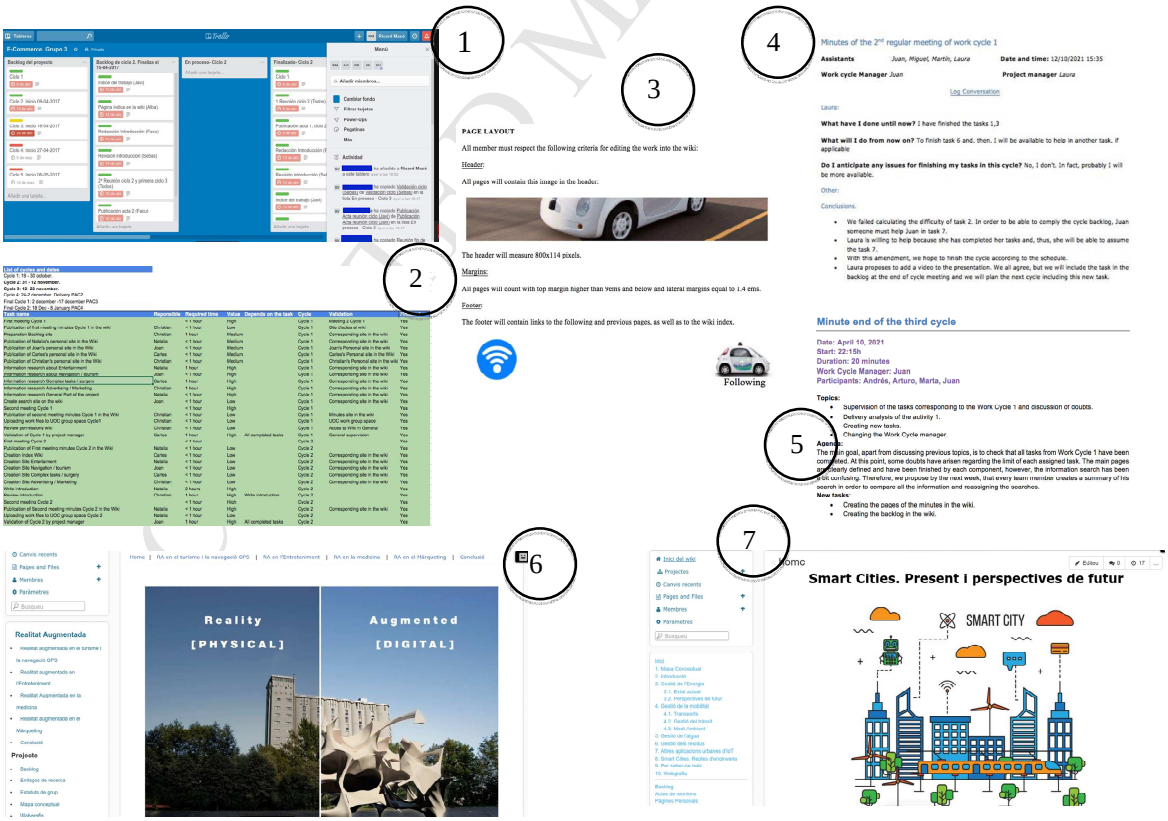

Fig. 3.
Screenshots of the work performed by teams during the project.

Although the aim of this article is not to compare virtual and face-to-face learning, it must be pointed out that some adaptations were made with respect to the agile designs tested in educational contexts and described in the literature. In these examples, the agile strategies were implemented in secondary face-to-face education. When the agile method is incorporated into the online context, some modifications are needed in regard to communication parameters and length of sprints. On the one hand, the *eduScrum guide* proposes five-minute regular meetings at the beginning of every class, which requires two adaptations to the online university context. The first of these is that students may consider the personal agenda and availability of each member when arranging regular and end-of-WC meetings. These meetings could not be linked to the class sessions, as sessions did not usually exist in online education. Our recommendation was to do at least two monitoring meetings per WC plus an end-of-WC meeting. Second, the length of the regular meetings had to be superior to the five minutes that was implemented in previous experiences. There may be connectivity issues, as the meetings were conducted online through video conference tools, and, because the meetings were not as frequent as in face-to-face education, there were more topics to handle. Thus, our recommendation was to test the connectivity before the agreed time and to conduct meetings of 10-15 minutes. On the other hand, the length of the sprints – which in previous experiences were comprised of two months – was associated with the duration of the semester and the existing project phases in the case of our pilot. Thus, the WCs were organised by months.

The third phase of the project, Closure and Dissemination, was not modified, although some adjustments were made to the assessment. The existing assessment criteria were reviewed and adapted to evaluate the 'online collaborative work' competency and the skills referred to agile project management in particular. The project was comprised of the delivery of four assessment activities: Activity 1, project definition and team creation (20% of the final mark); Activity 2, planning and initial project development (25% of the final mark); Activity 3, full project development (25% of the final mark); and Activity 4, presentation and project defence (30% of the final mark). The criteria were organised in relation to the course activities. Table 4 provides some examples of the assessment criteria defined for each activity.

Table 4.
Assessment criteria.

Activity	Examples of criteria
Definition	The topic has been initially explored and analysed by each member.
	The topic is aligned with the knowledge area.
	The topic is feasible.
	The selection of the topic has been properly justified.
Design	The difficulty for each task is correctly estimated.
	The course calendar has been considered when planning the project.
	There is a fair distribution of tasks among the team members.
	Each member has assumed responsibilities for each WC.
	The tasks have been appropriately allocated to each WC.
	Each task ends within the WC.
Development	The group activity has been periodically monitored.
	Each member has planned their tasks for each cycle.
	After each cycle, all tasks have been evaluated and decisions made regarding planning.
	The Project Manager has maintained the consistency of the backlog.
	The WC Manager has effectively responded to unexpected situations.
	The WC Manager has monitored the performance of all tasks by team members.
	The meeting minutes have been periodically uploaded.
Presentation	Key information has been selected.
	The information regarding the project is clearly organised.
	The main goals are clearly stated and met.

5. Results

5.1 Usefulness of the agile strategies for team regulation (RQ1)

Fig. 4 illustrates the students' perceptions of the usefulness of the agile strategies in regard to 'team regulation' (i.e., distribution of roles, monitoring meetings, end-of-WC meetings). Data from the two semesters during which the agile method was implemented are summarised and the percentage of respondents per each item is indicated.

Findings reveal that almost all respondents (an average of 97% from both semesters) affirmed that distributing the roles with respect to the new roles based on the agile method was very helpful for group dynamics and for assigning responsibilities. During the first interview, the teacher argued that creating new roles, defining the associated tasks and promoting the rotation of roles made it easier for students to accept responsibilities, identify who was responsible for each task, and eliminate hierarchies. This coincided with the students' opinions. Thus, roles and responsibilities were shared among group members and trust between them increased. Furthermore, conflicts between team members due to unequal involvement disappeared. As a result, the teacher reported feeling that group commitment increased compared to previous courses.

However, during the second interview, the teacher stated that the role of WC Manager was better defined than that of Project Manager. The tasks of the Project Manager were too general and sometimes there was an overlap with the WC Manager's tasks:

> Determining and distributing the roles has helped students to better comprehend the organisational group model, and it has been quickly shared among group members. Unlike what happens in other work models, these responsibilities are not hierarchical; on the contrary, it is a pragmatic distribution of work where the responsibilities are clearly defined. These responsibilities are rotational and are well-accepted among students. Hierarchies have disappeared. (Teacher, first interview)

> The roles are quite successful within the groups. However, the WC Manager is more successful as it is a more operative role. The responsibility of the Project Manager is a little bit vague. (Teacher, second interview)

In the open item in the complementary survey, some students reflected on the need for team commitment to explore the full potential of the agile method or mentioned how it might be difficult to implement such a method with strangers. In this regard, the teacher commented during the second interview that group commitment in agile project management is even more important than in traditional project management. He believed that losing one group member for a period of time or indefinitely during the project had an enormous impact on the project. He then proposed new strategies to deal with this issue, such as finding new criteria that help promote group commitment and stability, more accurate planning to avoid periods of inactivity, or personalised monitoring:

> It is necessary to find new criteria for increasing the loyalty and commitment between the group members due to the impact that disaggregation may have. Guaranteeing the stability of the groups, as experience demonstrates, is one of the challenges to overcome. (Teacher, second interview)

In regard to the communication strategies, the majority of respondents (a 91% average from both semesters) believed that monitoring meetings were very useful for work coordination and to anticipate deviations in the planning. The majority (86%) also considered the end-of-WC meetings to be very useful and 82% of them asserted that the agile method simplified the organisation of teamwork. The teacher was less enthusiastic than students regarding meetings, however. Although he felt that team meetings were more effective thanks to the agile guidelines (e.g., creating agendas, delimiting the time duration, assigning people responsible for dynamic meetings), it was a challenge to incorporate regular group meetings while maintaining the principles of asynchrony and autonomous learning according to the

pedagogical model of the UOC. During the second interview, the teacher confirmed that he was designing a strategy for reducing synchronous communication by reporting individual processes in a shared space. Furthermore, he regretted that the constant improvement and review processes did not always facilitate project advancement:

> Introducing synchronous communication was difficult. The agile process requires regular meetings during which students must interact almost every day. Making this strategy compatible with autonomous learning while monitoring that the time dedication does not exceed the time planned for the course is the main challenge. (Teacher, first interview)

> I am currently working on monitoring templates to allow team members to track their individual progress in a shared repository asynchronously so that the WC Manager and all team members can monitor group activity. (Teacher, second interview)

In contrast to the opinion expressed by the teacher, a greater number of respondents (92% of respondents from both semesters) believed that by incorporating agile strategies into project management, they still had a significant chance to work autonomously. In this regard, the teacher expressed different opinions. During the first interview, he mentioned that the agile strategies helped assess group dynamics and individual monitoring, as he disposed of instruments that offered him objective information about students' participation (e.g., meeting minutes, task list updates). Conversely, during the second interview, the teacher admitted that helping students to regulate their time dedication so as to not exceed the maximum course dedication planned was quite difficult. He argued that if students work autonomously and are self-regulated, the monitoring process becomes harder for the teacher. He mentioned that he believed that the only solution is for the teacher to become part of the team (e.g., participate in meetings), although such an option is difficult to implement with a large number of students. He proposed creating new instruments for improving the students' monitoring.

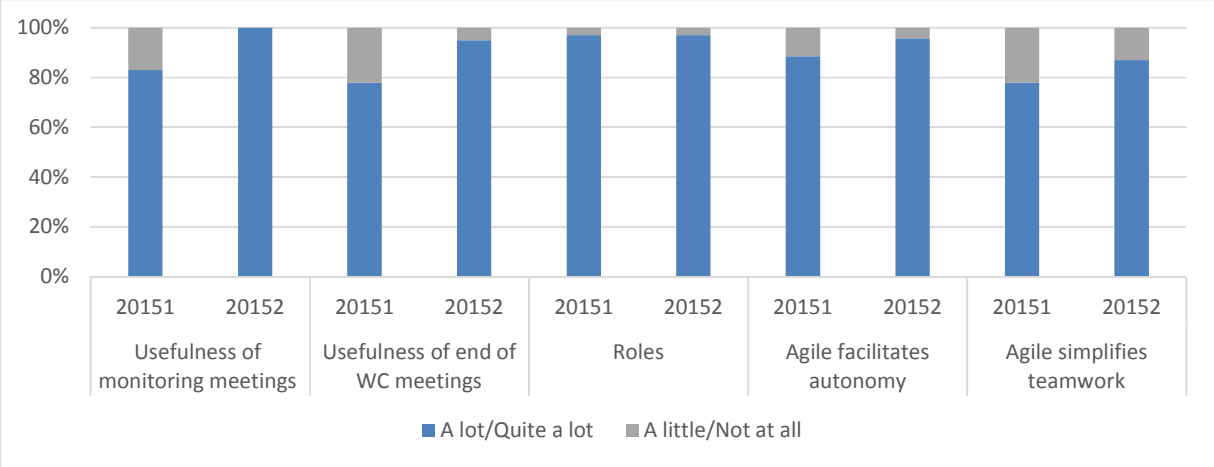

Fig. 4.
Bar chart contrasting the 'team regulation' category between two semesters (20151-20152).

5.2 Usefulness of the agile strategies for project management (RQ2)

Fig. 5 illustrates the respondents' answers in percentages for the items concerning the 'project management' category (i.e., backlog, WCs). Data from the two semesters during which the agile method was tested are summarised. The results show that WCs were considered to be very useful by the majority of respondents, with an average total of 92% from both semesters. Almost all respondents, (an average of

98% of respondents from both semesters), affirmed that the project task list was also very useful for project management and planning. Furthermore, a high number of respondents (87%) agreed that the agile method facilitated their project management.

During the first interview, the teacher agreed with this. He reported that his sensation was that WCs and task lists helped diminish the usual impact of the fluctuation in the students' dedication on the project and teamwork. Incorporating small tasks and WCs into the project facilitated reassigning and/or reformulating tasks, as well as the ability to continue working and advancing even when there was a lack of individual commitment or unexpected individual difficulties that affect project planning. During the second interview, the teacher reaffirmed this perception and argued that despite individual dropouts, all groups that initiated the project finished it, which indicated to him that personal situations did not affect the teams.

> The key is that in agile project management the work is planned based on small and definite tasks. Working on small tasks is easier, and it is simpler to distribute and redistribute such tasks. (Teacher, first interview)

The teacher also perceived that working in cycles and creating task lists improved the students' dedication to the project in terms of continuity and adjustment to course time dedication. In his opinion, working in cycles helps predict time efforts and distribute students' responsibilities. Organising the work into tasks also promotes constant participation within the project. Furthermore, using visualisation tools and assigning a status to tasks helped teams to visualise the project flow and react to contingencies. From the teacher's perspective, using the Trello tool facilitated the monitoring of the students' learning process. During the second interview, the teacher reiterated this perception and confirmed that the task lists were correctly completed throughout the project, and the average team's deadline delay was almost eradicated. In contrast, the teacher detected that the time constraints in WC frequently entailed finalising tasks without achieving the desired quality:

> Working in cycles probably gives students a more predictable scenario. This predictability allows them to more accurately adjust their dedication to the course and, above all, their individual planning. (Teacher, first interview)

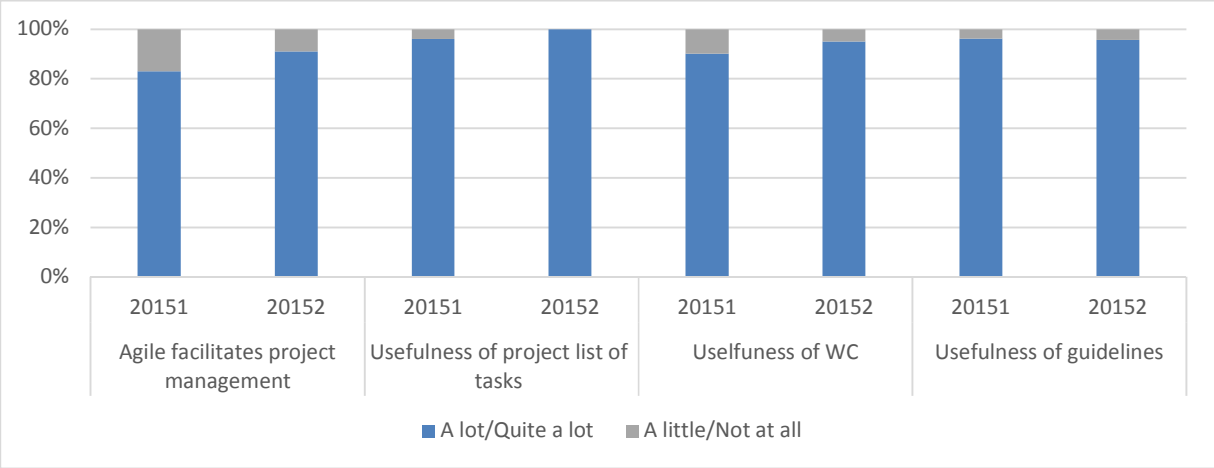

Fig. 5.
Bar chart contrasting the 'project management' category between two semesters (20151-20152).

Regarding the 'knowledge of agile' category, Fig. 6 shows the percentage of respondents' answers for each item. Almost all respondents (an average of 96% from both semesters) declared that they were very

confident in the knowledge acquired, and a significant number of them (87%) agreed that they might transfer their acquired knowledge of agile to other life contexts. The teacher agreed that the proposed learning activities were more significant for students, since the agile strategies implemented will be commonly used in their future professional environments. However, he also stated that the real impact did not rest in the incorporation of the agile method, but in having transmitted the importance of selecting a work methodology that systematises and organises the work process to students. Furthermore, the teacher argued that it was a challenge to adapt the characteristics of the agile methodologies into an educational context without it resulting forced for students.

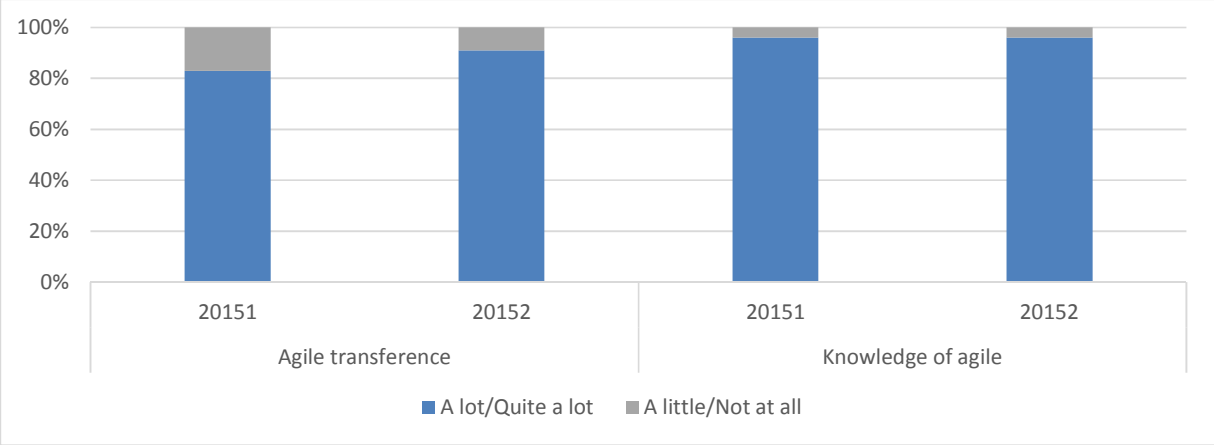

Fig. 6.
Bar chart contrasting the 'knowledge of agile' category between two semesters (20151-20152).

5.3 Student satisfaction (RQ3)

Descriptive information for each category concerning students' satisfaction is presented in Table 5, comparing in which the means [M] of the values from semesters prior to the incorporation of the agile method and the semesters in which the new course design was piloted are compared. Means are calculated for each semester separately and jointly. Findings reveal that student satisfaction did not significantly change during the pilot in comparison to previous semesters. As in past semesters, the items referring to the teacher were the most highly valued (a mean value of 4.60), followed by the items related to the type of assessment (a mean value of 4.31). The items referring to resources had the lowest values both before and after the pilots (with a mean value of 3.74), in contrast to the findings from the complementary survey, in which almost all respondents (a 96% average from both semesters) declared that the guidelines and resources received were very or quite useful for developing the project and for understanding how agile strategies can be applied.

The overall course satisfaction slightly increased during the pilots (0.03 points). This result coincides with the perspective of the teacher, who commented that there is a meaningful impact on course satisfaction merely in cases in which the teaching method is poorly defined. On the contrary, in cases in which the teaching method is accurately designed, as in the case of this course, there is not a direct impact on course satisfaction. Broadly speaking, respondents were highly satisfied with the course during the pilots and rated all categories with a score of between 3.74 and 4.60 on a scale from 1 to 5.

Table 5.
Comparison of category averages concerning student satisfaction during previous semesters and pilots.

Previous semesters	Pilots

Category	20141 (n=24)	20142 (n=9)	20141-20142	20151 (n=11)	20152 (n=7)	20151-20152
	M	M	M	M	M	M
Overall satisfaction	3.98	4.47	4.23	4.22	4.30	4.26
Teacher	4.31	4.39	4.35	4.55	4.65	4.60
Resources	3.85	4.21	4.03	3.67	3.82	3.74
Assessment	4.10	4.49	4.30	4.09	4.54	4.31

Table 6 summarises the descriptive statistics (means [M] and standard deviations [SD]) of items that refer to the agile strategies considering the semesters independently and jointly. The items that refer to the WCs (Item 8), the project backlog (Item 9), and the monitoring meetings (Item 3) are the best rated during the pilots. The items regarding knowledge of agile (11), autonomous work (5) and transference (12) are the worst rated. Nevertheless, the mean for all items is higher than 3 points on a scale of 1 to 4, which indicates a positive view of the agile strategies implemented.

Table 6.
Descriptive statistics for categories concerning students' perceptions of the agile strategies implemented in two semesters.

	Semester 20151 (n=26)		Semester 20152 (n=23)		Semesters 20151-20152	
No.	M	SD	M	SD	M	SD
1.	3.23	0.51	3.47	0.59	3.35	0.55
2.	3.23	0.51	3.47	0.59	3.35	0.55
3.	3.42	0.86	3.60	0.50	3.51	0.68
4.	3.11	0.71	3.39	0.72	3.25	0.71
5.	3.03	0.53	3.21	0.52	3.12	0.52
6.	3.19	0.75	3.21	0.67	3.20	0.71
7.	3.23	0.71	3.30	0.63	3.27	0.67
8.	3.23	0.86	3.69	0.47	3.46	0.67
9.	3.53	0.58	3.65	0.49	3.59	0.53
10.	3.07	0.63	3.47	0.51	3.27	0.57
11.	3.11	0.43	3.17	0.49	3.14	0.46
12.	3.03	0.66	3.30	0.76	3.17	0.71

5.4 Learning outcomes (RQ4)

During the first interview, the teacher affirmed that final marks slightly increased during the piloted course. Nevertheless, he felt that learning products improved in students with lower grades, which made the overall class level increase. From his perspective, the agile strategies incorporated helped low-level students organise their work, be more effective and overcome unexpected situations. These affirmations have been contrasted with the learning outcomes. In Table 7 and Table 8, the mean of students' learning outcomes (percentage of students per mark and mean of final marks) are compared between the semesters with the agile method and the prior semesters without it. In accordance with the teacher's perspective, it can be observed that the mean score of the final mark increased 0.03 points during the semesters that the agile method was tested, which is not significant. On the contrary, the percentage of students for each mark (A, B, C+, C-, D) demonstrates that higher marks have increased during the pilots.

Table 7.
Comparison of means concerning marks prior to and after the implementation of the agile method.

	Previous semesters			Pilots		
Marks	20141 (n=52) Mean	20142 (n=39) Mean	Mean	20151 (n=58) Mean	20152 (n=56) Mean	Mean
No-show	27	13	20	29	18	24

A	17	26	21	33	25	29
B	40	33	37	19	34	26
C+	12	28	20	16	23	19
C-	0	0	0	3	0	2
D	4	0	2	0	0	0

Note: Marks are expressed over the percentage of students and rounded to the nearest integer.

Table 8.
Descriptive statistics comparing final marks between semesters.

	Previous semesters						Pilots					
	20141 (n=52)		20142 (n=39)		20141-20142		20151 (n=58)		20152 (n=56)		20151-20152	
	M	SD	M	SD	M	SD	M	SD	M	SD	M	SD
Final mark (10-point scale)	7.59	1.70	7.65	1.35	7.62	1.53	7.63	1.71	7.68	1.32	7.66	1.51

Note: Final marks are expressed as the mean of marks.

6. Discussion

This study examined the impact of an agile-based course design for collaborative project management on student and teacher perceptions as well as students' satisfaction and learning outcomes.

6.1 Perceptions on the usefulness of the agile strategies for team regulation

Leadership is widely recognised as a key factor in team effectiveness and must serve two basic functions: task management and team development (Eubanks, Palanski, Olabisi, Joinson & Dove, 2016). In our proposal, the roles of WC Manager and Project Manager aim to facilitate group dynamics and help organise and carry out tasks. Our findings reveal that defining roles with associated tasks and responsibilities – including those inspired by the agile method – is a useful strategy for facilitating group dynamics. Assigning tasks to roles helps teams to identify and assume responsibilities and reduces conflicts. Regarding the specific roles introduced in this study, the role of WC Manager proved easier for participants to execute, while the role of the Project Manager needed some revision for better delimiting its tasks and responsibilities. On the other hand, the role rotation strategy was useful for avoiding hierarchies, according to the teacher who participated in the study.

By incorporating the agile roles and maintaining project-based roles, all members possess a core function in the team and, consequently, their commitment becomes fundamental for ensuring a project's success. Everyone is expected to contribute, to be responsible, and to be involved throughout the collaboration process. According to the teacher who participated in the study, the impact of students' drop out on collaborative agile project-based learning may be higher than in traditional project management, even though the agile method facilitates an easy reassignment of tasks. Thus, new strategies are required for helping maintain group organisation when one team member does not fulfil her or his responsibilities. This may include new criteria for promoting group commitment and stability, more accurate planning for avoiding periods of inactivity, or personalised monitoring, for example. In light of the teacher's reflections, it could be interpreted that the distribution of responsibilities and functions promotes team commitment and self-regulation, despite cases in which there is an individual lack of commitment. Such team self-regulation may hinder the teacher's group monitoring. Thus, the role of the teacher in monitoring must be reconsidered to determine whether or not the teacher should be more integrated within teams or if new strategies are necessary for collecting more evidence of the groups' progress.

In the given design, the role of the teacher is comparable to the role of Product Owner. The functions include providing guidelines and clarifications about the project and the method, monitoring teams'

activity, and reviewing project development (i.e., backlogs, minutes, WCs, products). As a result of the observation of the development of agile strategies, it has been revealed that the teacher plays a fundamental role in team dynamics. This finding is consistent with previous results obtained by other studies on online and collaborative learning (Ozkan & Koseler, 2009; Paechter, Maier & Macher, 2010; Ku et al., 2013; Diep, Cocquyt, Zhu & Vanwing, 2016; González-Marcos, Alba-Elías, Navaridas-Nalda & Ordieres-Meré, 2016). Although teams apparently become more self-regulated as the course progresses, a high teacher presence is needed during the first phase of the project to propagate the agile philosophy, promote a sense of belonging in groups, and to implicate students in tasks.

As for the initial strategies implemented in the course design (i.e., roles and task distribution and the document of agreement), results indicate that these strategies helped initiate a shared regulation process of task understanding, goal negotiation and planning (Miller & Hadwin, 2015). In our design, the document of agreement sought to initiate the creation of common understanding and planning as well as to lay the foundation for a good team atmosphere. As reported by Ku et al. (2013), the initial document of agreement may help teams to share personal beliefs, backgrounds, and interests and to establish a basis for creating positive relationships. According to Nam (2014), the team climate is crucial for effectively structuring and encouraging trust among learners. Trust among teammates is highly strengthened if an initial preparation phase is incorporated, such as the one presented in our course design. This preparation phase can help students to determine what they can expect from their team members, establish equal time dedication from all teammates, and fix common rules and procedures for dealing with team behaviour.

With respect to the communicative strategies, findings demonstrate that monitoring and end-of-WC meetings are very useful for coordinating work and anticipating deviations. Continuous reflection on the process and product facilitates the continuous incorporation of changes without compromising the quality of the final product. The information required from students during each regular meeting (i.e., work done, future work, issues) is helpful for refining the malfunctions from small responsibilities, communication problems or other typical teamwork problems. Creating agendas and defining people responsible to make meetings more dynamic also increases the effectiveness. Nevertheless, the time constraints, synchronicity and the regularity of meetings must be reconsidered in the design, as they may affect the quality of the tasks developed for each WC and the students' autonomy. In consequence, the need for periodic synchronous communication must be reconsidered, and new strategies should be examined for maintaining regular reporting.

In summary, results show that the agile method simplifies group regulation as it helps with task management and group dynamics. However, the proposed agile-based course design must be revised to better delimit the role and tasks of the Project Manager, to deal with individual drop out, and to incorporate new instruments for individual and group reporting.

6.2 Perceptions of the usefulness of the agile strategies for project management

Results show that task lists and the WCs benefit project management and planning. Using these strategies makes it easier to reassign and reformulate tasks and continue to work when there is a lack of individual commitment. Listing tasks and responsibilities promotes constant participation in the project and helps teams to visualise the project workflow and react to contingencies. The specific guidelines given for organising the task lists (i.e., assigning responsibilities, time dedication, value, indicators, deadlines, and status) and the visualisation tools proposed (i.e., Trello) can be helpful for predicting efforts and avoiding overlap and work overload. Furthermore, according to Slof, Erkens, Kirschner and Helms-Lorenz (2013), the process of constructing such visualisations also benefits learning. This is because students need to reflect on the project and group organisation for listing and making decisions on the tasks and, consequently, learn from the process itself. From the teacher's perspective, the visualisation tool does help visualise the students' learning process (Malmberg et al., 2015). However, as previously argued in Section 6.1, more information is required regarding students' learning processes.

Despite the positive results regarding the organisation of work in tasks, some issues were raised during the observation. Sometimes, daily circumstances and workloads made students forget the essence

of the agile principles and only concentrate on tasks. Findings from previous research demonstrate that teams sometimes simply jump into task completion with little attention to what is required (Miller & Hadwin, 2015). In agile projects, the process is as important as the results and, for that reason, transmitting the value of the process for developing the project is fundamental. According to Nam (2014), if online group members concentrate on task-oriented activities too much, they fail to obtain strong cohesiveness and feelings of trust, belonging and satisfaction. Thus, based on the experience from the study presented in this paper, it is key that teachers transmit to students the essence and value of the agile strategies implemented during the project development process to give meaning to the task performance and methods. In this study, the incorporation of the agile strategies aimed to improve teamwork and project development. Apart from achieving the expected objectives, almost all of the student participants affirmed that they also gained theoretical knowledge on the agile method. In addition, both the students and the teacher agreed that the incorporation of the agile method made the course activities more meaningful and they considered the knowledge acquired to be transferable to other contexts.

Concerning the WCs, results indicate that this strategy helps predict time efforts, which in turn reduces the delay in delivering tasks. Although organising work by cycles may help teams to guide team decision-making and the adaptation of collaborative processes, progress, and products (Miller and Hadwin, 2015), it is difficult to adopt this organisation method. This observation proves that the current WC design may imply negative consequences, such as finalising tasks not achieving the desired quality due to time constraints and difficulties in advancing in the project due to the review processes. For this reason, one of the teacher's responsibilities is to help students efficiently plan and manage their efforts to incorporate improvements as WCs and project phases advance. Teams must find a balance between the adaptation capacity, the quality of the product, the time availability, and the dedication required.

In brief, results demonstrate that the agile method facilitates project management. Nevertheless, the role of the teacher is crucial in the agile method for transmitting the value of the process itself and for helping students to adapt their efforts to the required tasks.

6.3 Student satisfaction

These findings show that overall course satisfaction slightly increased during the pilots. Similarly, the agile strategies appear to have positively impacted student's satisfaction regarding the teacher and the type of assessment. However, the increase in student satisfaction with the teacher contrasts with the teacher's perception of the issues experienced while guiding students (e.g., maintaining students' autonomy while promoting collaboration, helping regulate students' dedication, monitoring team activity, integrating the agile strategies in the course design). A plausible explanation for the students' positive opinion of the teacher may be that the teacher's role and responsibilities in the redesigned course were better defined than in previous courses. As for the type of assessment, the redesign of assessment criteria and their association to activities and the agile strategies may have helped to increase the students' satisfaction.

Data from the institutional survey reveals that satisfaction with learning materials is lower during the pilots than in the previous courses, while in the complementary survey, almost all students considered the materials and guidelines provided during the course to be very useful. This contradiction can be interpreted by taking into account that the item in the complementary survey mentioned both the learning materials and the teacher guidelines. Thus, the students were probably more satisfied with the teacher guidelines than with the learning materials, as results from the institutional survey show. Bearing in mind such findings, a new learning resource has been developed for improving the description and students' sense of the agile strategies implemented in project management.

The low response rate in the institutional satisfaction survey can be explained due to two factors: a) Completing the survey was not mandatory and, b) Students were called to complete a total of five surveys about various aspects regarding satisfaction and the agile method during the course, which may have created an overload and disinterest.

Regarding the specific agile strategies, students reported being the most satisfied with the WCs, project backlog, and monitoring meetings, while they were less satisfied with the acquired knowledge of agile strategies and its transference to other contexts and autonomous work. This may be a result of the fact that more emphasis was placed on the specific agile strategies than the collateral effects that they may have on students in the redesigned course. The incongruence detected by the teacher between the Project Manager and the WC Manager role may explain the value given by students to the item corresponding to the roles (mean value of 3.35). The vagueness of the Project Manager role and its overlap with the WC Manager functions likely affected the teams' regulation. Furthermore, despite the fact that the monitoring meetings were highly appreciated, the value obtained with regard to the end-of-WC meetings (mean value of 3.25) could indicate that these review moments were not as fruitful as desired due to the time constraints.

In summary, the students' satisfaction did not increase after the agile method was integrated, although the satisfaction with the teacher and the type of assessment did rise. As for the agile strategies, students were more satisfied with WCs, project backlog and monitoring meetings. In the case of the piloted course, more attention should be paid to the learning materials in the future.

6.4 Learning outcomes

This study reveals that the use of a teaching method that helps project management and group dynamics does not have a significant impact on the overall learning outcomes. The mean score for the final mark did not change significantly, although the higher marks increased. Surprisingly, the findings demonstrate that although the final marks did not increase, there was an increase in the number of higher marks. In contrast to the teacher's opinion, the agile strategies helped high-level students instead of low-level students. Apparently, the agile strategies have favoured the development of social regulation and organisational competencies in high-level students.

7. Conclusion, limitations and future research

This study attempted to propose an approach for implementing the agile method into the online higher education context. The results obtained from students' surveys and the teacher's interviews reveal that the agile strategies incorporated into project-based learning facilitated team regulation and project management, although students' satisfaction and overall learning outcomes did not increase. Our work showed fruitful results in incorporating the agile principles into an educational context that differs from face-to-face secondary education. Nevertheless, the design requires some adjustments to deal with the encountered issues. This will involve redefining the role of Project Manager, incorporating new strategies for diminishing the impact of drop outs, introducing new instruments for group reporting, and enforcing the teacher's role in transmitting the agile method and helping to distribute efforts. These findings have several implications for practitioners for the design and support of collaborative projects. The methodology presented in this paper offers a basis to transform collaborative projects into agile processes; however, it requires that teachers invest time and effort to select and accommodate the agile strategies into their particular contexts. Once the first design is developed, a cyclical process of testing and refinement is indispensable to improve the teaching method. Teachers need time to learn how to manage such processes and to find their place in this new scenario while students must learn to self-organise and to be autonomous when working in teams. In consequence, three main challenges arise for teachers: 1) to assume that self-regulated learners cannot be continuously monitored, 2) to help students find the balance between autonomous and collaborative learning, and 3) to support teams to maintain group stability, commitment and frequent communication.

From the research point of view, the small sample of students limits the generalisation of results from this study. Further investigation should be conducted with a larger sample of students from diverse courses in order to demonstrate the transferability to other disciplines and to obtain a consistent

application pattern. The major implications of this study for researchers are, firstly, to consider the field of collaborative learning as an evolving approach that can be nourished by other fields and professional working methods. Secondly, to surpass the theoretical discussion on collaborative learning and provide evidence on how some methodologies, like project-based learning, could be effectively implemented in practice by facilitating specific strategies and indications. Thirdly, to highlight that collaborative learning is sometimes vaguely presented to students who perceive team-based tasks as unfathomable. Although the agile strategies reported positive results in this study in terms of team regulation and project management, further research should explore new modes to enhance group commitment and communication within teams in online learning environments. Finally, it should be investigated which strategies are useful to motivate low-level students to obtain higher rates through agile processes.

Appendix 1. Items used to measure students' satisfaction.

	Items
Overall course satisfaction	
1.	The objectives of the course meet my expectations
2.	The contents of the course are aligned with the objectives
3.	The workload of the course is aligned with the number of ECTS credits
4.	The content is useful (at a personal or professional level)
5.	Overall satisfaction with the course
Course instructor	
6.	The course instructor masters the course content
7.	The course instructor has properly planned the course
8.	The course instructor has facilitated my learning process
9.	The course instructor has offered me personalised support during my learning process
10.	The course instructor answered my questions in an appropriate period of time
11.	The course instructor clearly answered the questions posted by students
12.	The course instructor has coherently assessed my learning process
13.	Overall satisfaction with the course instructor
Teaching-learning resources	
14.	The instructional materials and resources are updated
15.	The learning activities proposed facilitated my learning
16.	The way the instructional materials are organised facilitates learning
17.	The instructional materials include elements (links, quotes, examples) that facilitate the assimilation of content
18.	The section of the virtual classroom 'Information Sources' presents useful content
19.	The section of the virtual classroom 'Information Sources' is organised in an understandable way
20.	In the section of the virtual classroom 'Information Sources', I can easily find the information I need
21.	Overall satisfaction with teaching and learning resources
Type of assessment	
22.	The type of assessment is appropriate given the course objectives and the content to accomplish
23.	The continuous assessment activities have helped me to pass the course
24.	The final exam was coherent with the continuous assessment activities
25.	In case you were not assessed based on continuous evaluation, the final exam was coherent given the course's objectives and contents
26.	Overall satisfaction with the type of assessment

Key to mean values:
1. Strongly disagree
2. Disagree
3. Neutral

4. Agree
5. Strongly agree

Appendix 2. Items used to measure students' perception of the agile strategies implemented.

	Items
	Team regulation
1.	Do you consider the documentation about the agile methodology facilitated during the course through the notice board or in the learning resources to be useful?
2.	Do you believe that the distribution of roles of Project Manager and WC Manager are helpful for group dynamics and distributing responsibilities?
3.	In your opinion, have the monitoring meetings been useful for work coordination and for anticipating deviations throughout the planning?
4.	Do you believe that the end of work cycle meetings have been helpful for planning the project?
5.	Do you believe that the agile methodology allowed you to work autonomously?
6.	Do you believe that the agile methodology helped simplify teamwork organisation?
	Project management
7.	Do you think that the agile methodology has facilitated project management during the course?
8.	Do you believe that splitting the work into cycles is helpful for project development?
9.	Do you think that the project task list is a helpful instrument for project management?
10.	In your opinion, has the agile methodology been useful for completing the project?
	Knowledge of agile
11.	How would you rate your current level of knowledge of agile methodologies?
12.	Do you believe that you will be able to transfer the agile methodology to other contexts in your life (professional, academic or personal)?
13.	Open comments.
Key to mean values:	
1. Not at all	
2. A little	
3. Quite a lot	
4. A lot	

Appendix 3. Questions used to measure the teacher's perception of the agile strategies implemented.

Items
Interview semester 20161
1. What difficulties have you encountered for adapting the agile methodology to the course design?
2. What difficulties have you encountered for guiding students in the development of the agile project? Was there reluctance on behalf of the students?
3. Do you feel that the management and monitoring of group projects have improved thanks to the agile strategies?
4. Do you believe that students' project management processes have improved thanks to the agile strategies implemented?
5. Compared to previous years, do you think that it has been useful for students to divide the process into work cycles? Have the follow-up meetings been helpful for foreseeing deviations? Have the final cycle meetings been useful and effective for making decisions? Have the project and cycle task lists been useful?
6. Do you believe that the teamwork process has improved thanks to the incorporation of the agile strategies? Have the students completed the tasks associated with the established roles (Project Manager and WC Manager)?
7. Do you believe that using methodologies from the students' future professional world makes the main activity (the project) more significant to them?
8. Do you believe that the quality of the process and the final product increase because of the incorporation of agile strategies?
9. Do you feel that students have better acquired some of the course competencies? Which ones?

Interview semester 20171

1. Do you think that the students' satisfaction with the course has improved thanks to the agile strategies implemented? Why?
2. Do you think that the agile strategies implemented have improved the teamwork processes and products in comparison to previous courses? Why?
3. Do you think that students' teamwork is better regulated thanks to the agile strategies (that is to say: better definition of roles, better distribution of responsibilities and tasks, and more frequent and effective communication)?
4. Do you think that the projects are better managed by students thanks to the agile strategies (that is to say: tasks are better scheduled, students have more control over pending and completed tasks, and they have time enough to improve the project on the go)?
5. Have you made any changes to the design over the first model you implemented? What has changed and why?
6. Is there any strategy that does not work or you decided to eliminate? Why?

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Highlights:

- Distributing responsibilities and rotating roles facilitate group dynamics.
- Regular meetings help coordinating work and anticipating deviations.
- The task lists and the work cycles benefit project management and planning.
- Teachers propagate the agile philosophy and implicate students in groups and tasks.
- Students' commitment and monitoring and the Project Manager role must be enhanced.