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RESEARCH ARTICLE

Creation and Sharing of Lessons Learned by Blogging in the Context of Project-Based Learning

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ABSTRACT The knowledge acquired during the execution of projects developed in organizations is captured and published in the form of lessons learned with the objective of being able to apply them in subsequent projects. Effectively reused lessons have an impact on projects, for example, by increasing their quality and reducing their execution time. In an educational context, these lessons can be integrated into project-based learning experiences. Lessons are content generated by students for students, in the same or subsequent courses, who could benefit from reading them. We have applied, for four consecutive academic years, a specific cycle of lessons learned management in a course where project-based learning is carried out using a blog developed with Blogger as a platform for publishing and open access to these lessons. We have analysed student opinions about reading, detecting, and generating lessons as well as the profiles of students most likely to detect and generate lessons. A total of 162 students who developed 154 lessons are included in the study. A statistical analysis is performed to evaluate lessons learned generation. The results indicate that lessons learned generated by peers are useful for learning and have a strong influence on the outcomes of their work. The activity of generating new lessons is difficult and moderately satisfying. Finally, the profile of a student who creates quality lessons corresponds to someone brilliant, whose work is valued both by their teammates and themselves, and who is also attentive to the activities carried out in the course. The implications of this work are that lesson generation is well suited to project-based learning and that students generate an interesting number of quality lessons with the instructor's support and encouragement.

INDEX TERMS Blogging, lessons learned, peer learning, project based learning, student-generated contents.

I. INTRODUCTION

A lesson learned contains knowledge acquired while performing a project in an organization. This knowledge is identified, captured, and published for application to future projects for improved execution performance [1], [2]. The knowledge embedded in Lessons Learned (LL) can come from both successes to emulate and failures to avoid. The benefits of the application of good LL are documented in several studies conducted in the field of organizations that carry out projects, highlighting reduced execution times and the more likely successful completion of a project [3], [4].

Considering that in project-based learning (PBL), project development is used as a learning mechanism [5], [6], having a set of appropriate LL could bring benefits to the learning process itself. In the context of PBL, learners can document LL in a similar way as it is done in organizations. Their contents will have been detected, recorded, and shared

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during the course of the projects and the LL achieved could be useful for peers in the same or subsequent years. Therefore, in the educational setting, reading and applying LL would be a form of Peer Learning [7] through Student-Generated Contents [8]. The idea of collecting LL in education is not new, previous experiences or models have proposed the collection of student-created LL, but only as an end in itself that would not involve other students reusing that knowledge [9], [10]. Nonetheless, the raison d'être of LL is to apply them at some point. To the best of our knowledge, no cycle of LL creation, storage, and dissemination associated with PBL in the educational context has been proposed in the literature. This paper aims to fill this gap.

Since LL must be shared among project team members (either employees of an organization or students) some means of storage and dissemination need to be used. For example, one can use some of the alternatives available in course management systems, wikis, websites, or video channels, among others [11]. Another interesting possibility is to use a blog. This is a tool that allows for the storing and publishing of LL, either restricting access to a set of users or keeping it opening to any visitor [12]. Blogs host mini-articles that support the embedding of multimedia objects; they are simple to manage and there are free alternatives that make them very accessible. In addition, blogs are a widely used medium in education, have been widely experimented with, and different learning benefits have been discovered thanks to them [13].

LL management is not free of difficulties and it is useful to be aware of the most common ones, and follow an LL application and generation cycle that tries to overcome or minimise them. For example, although most employees are usually satisfied reading LL related to a project, few are willing to make contributions [14]. The LL management cycle, which we will discuss in this paper, organises the dissemination and reading of LL that may be of interest to a project as well as the identification and writing of new LL. We have applied the cycle for several years using a blog, developed with Blogger, to store and publish LL. We have used a blog taking into account its ease of use, versatility, and the educational advantages identified in different studies [13], [15]. Both as far as reading and generating LL, it is interesting to find out the interests and difficulties perceived by students and what responses we can expect from them. Moreover, it is interesting to analyse whether behaviours similar to those observed in organizations occur. Therefore, we have posed the following three research questions:

1. What is the students' opinion about reading LL written by others and their practical usefulness?
2. What is the students' opinion about detecting and generating new lessons?
3. What is the profile of the students most likely to detect and generate LL of sufficient quality?

This article is structured as follows. In Section 2, we will analyse relevant literature. In particular, we will highlight the main benefits and problems encountered in organizations that manage LL in relation to project development, and the use of blogs in the educational context and the benefits derived from such use. In Section 3, we will present the LL management model that we intend to analyse. It is a cycle of activities around these contents which are carried out by and for students. In Section 4, we will explain the method we followed to answer the research questions, and in Section 5, the results obtained by applying the LL cycle over several academic years. Section 6 includes a comparative discussion of these results and Section 7 the implications of the study. The article ends with a conclusions, limitations and future work section.

II. RELEVANT LITERATURE

A. LESSONS LEARNED IN PROJECT-BASED ORGANIZATIONS

Lessons learned are knowledge gained during project execution experiences. They can include both successes and failures and are collected with the goal of improving performance in future projects [1], [2], [16]. An organization may capture many LL for their reading and application or for updating in subsequent projects. Their capture and effective dissemination among teams promotes and enhances organizational learning [16]. The well-known PMI project management guide places them at the input and output of all management areas. This implies that they can be identified, used, and updated during all phases of a project [17]. A study on the literature found that the acquisition and transmission of LL, in either a tacit or explicit way, were strongly related to both project execution efficiency and the success of the product or service delivered [3]. The same study also identified the two most widely used LL management strategies: acquisition and dissemination of knowledge by experts, and its documentation through forms [3]. Another study [4] recognised that LL have a strong effect on reducing project execution time and monitoring and control costs, while also encouraging the reuse of knowledge.

However, some researchers detected problems in exploiting LL [18]. Among the causes, they highlighted insufficient cultural acceptance of acquired knowledge management, low perceived value of LL, and choosing inappropriate IT tools to store them [2], [19] or hiding information to increase one's power [19]. This leads many organizations to not run their own LL documentation processes, either due to lack of time, loss of resources, or simply forgetting to write them [1], [2], [20]. In these cases, LL will be lost as soon as team members disperse or leave the organization [1], [19], [2]. Petter and Vaishnavi [14] found that more than half of the employees in an organization recognised the benefits of using LL but that less than 10% were willing to contribute new LL because of to the time and effort required. Another study found that employees were reluctant to contribute to LL because they record the errors made by the team [17]. Therefore, it seems necessary to encourage this activity in some way [14]. There are also organizations that have managed to implement good routines to identify and collect LL, but fail in their subsequent dissemination [1], [2], when it seems evident that the

usefulness of LL lies precisely in their application [4]. Simply creating a knowledge management system is not enough to stimulate knowledge reuse [14].

One tool that allows the collection and dissemination of LL are blogs [16], [17]. In them, LL are presented in the form of mini-articles [20]. Other viable formats are wikis, in the case of cooperatively written articles [14], [21] or video channels, when LL are recorded in video format [18]. Multimedia elements such as videos can be easily embedded for direct viewing in blog posts, allowing one to write LL that combine several media. Other options would be to use posts on social media platforms [22] or the question-and-answer format, as in the case of Stack Overflow [23], [24]. The latter resource is widely used in different domains, such as ICT, generally in a reactive way. This means that teams consult them when they encounter unforeseen problems [23], [24]. However, there are LL that precisely state the need for foresight or planning, for example, to avoid or minimise a problem or to follow an itinerary with a greater guarantee of success. Some technologies, such as wikis and blogs, enable collaboration between organizations, improving communication between them [17].

B. LESSONS LEARNED IN PROJECT-BASED LEANING

We could understand that a course (with students, topics, activities and so on) is, in a sense, like a small organization. Then, the ideas about LL can be applied to PBL in a course over the years. In this case, there is an added difficulty: the outstanding members of the teams only stay in the course for one year and, therefore, the knowledge they have acquired will disappear if it has not been captured in a format easy to transfer to others. The faculty's intervention will also be important, firstly by advising students in the identification and proposal of LL, secondly by adding value to the LL by suggesting improvements and helping in their writing and, finally, by disseminating them among students of subsequent courses, since the faculty will be the only effective link with the previous academic years.

In PBL, the aim is to learn while performing tasks that involve both research and application of resources [5], [6]. However, as in the case of projects developed by organizations, the experience leads to successes or failures that could enlighten future students developing similar projects. Some authors suggest introducing LL into PBL activities [7], [8], [12]. For example, interesting LL could explain errors in understanding concepts, work team organizational problems, or suggest interesting chapters, books or training videos, as well as examples or exercises with outstanding difficulties, web pages or computer tools that help in the performance of tasks or understanding of concepts, etc. Educational experiences of this sort include the creation of LL to identify difficulties and successes in managing a project for a client [10]. Another experience evaluated a method to improve problem-solving skills involving PBL and LL creation [9].

PBL use of knowledge and skills collected by means of LL is a form of peer learning [7]. Studies reflect that these methods can significantly improve academic performance. In addition, LL are student-generated contents. One study observed that university students produce good quality content when they are guided by an instructor and work collaboratively [25], a common situation in PBL practice. Moreover, when students engage in such activities, they end up being adequately trained and satisfied with the experience [25].

C. USE OF BLOGGING IN EDUCATION

Blog is the contraction of ''web log'', one of the most popular social media of Web 2.0 [26]. A blog is a tool which makes very easy to publish all kinds of articles, for both public and private audiences. It is also very simple to configure and administer, and suitable for users with little technical knowledge [27]. Besides articles, blogs can be supplemented with additional elements or gadgets, such as an internal search engine, a thematic index based on entry tags, an automatic translator into different languages, etc. Each blog article has an area where visitors can leave their comments, which blog editor can review and configure prior to public access. Visitors can give their feedback about quality or interest level by posting from one to five stars. Blogs also offer some options for the statistical tracking of visits received.

Presumably because of their simplicity, blogs have also gained popularity in the educational setting, where they are used to promote teaching and learning [13]. This use is being sustained over time, as revealed in a recent analysis of technology used in education [28]. The writing and publication of blog posts encourages students to discuss ideas, contributing to the improvement of their digital, social, and civic competencies, and increasing self-perceived motivation [29], [30]. Blogs can complement face-to-face classroom interactions through asynchronous feedback and ratings, offering students support and collaboration [31]. The fact that interactions are recorded and made public can positively influence their quality. Improvements in students' writing skills are also observed. Students are motivated and have a clearer objective based on the feeling of writing for an audience, the community of followers, which provides some social support [30].

Experimentation with blogs has taken place in a variety of educational settings. For example, in an educational experience in health sciences, the instructor used a blog to publish a weekly summary of the topics presented in the classroom [29]. A low use of the blog was reported, with one visit per student on average for each entry. In this same experience, the students, as a team, were asked to create a blog on a course-related topic. The development of the students' critical thinking and knowledge acquisition was observed, although they seemed poorly motivated and their participation was relatively low [29]. Blogs have also been used in the teaching of mathematics. An experience with children between 9 and 11 years of age used a blog to supplement classroom explanations [31]. The results suggested that a blog serves as a support for explanations and that the justifications and argumentations collected in the blog improved the equivalent classroom explanations as they were available for

later reading and reflection. In science teacher education [26], blogs were used to assess self-efficacy with internet tools and understanding of environmental problems, while in the teaching of English as a foreign language [32], blogs were used to work on writing. Both experiments compared the results of students who used a blog to those who carried out an equivalent activity, for example, using pencil and paper. The learning results of the first group were significantly better and satisfaction with the blog activity was positive. Blogging has also been used to enhance the effect of summer vacation on reading and writing [30], where a very positive effect was observed. The literature on blogs seems to indicate that they provide a very interesting option to the teaching and learning process and that students enjoy reading posts written by peers, but perceive writing new posts as an activity that involves some difficulty [26], [29], [32]. Some studies on the use of blogs [33], [15] concluded that students who contributed with more comments obtained better academic results and were more willing to learn from peers and interact with them online. On the other hand, we have not found papers analysing the characteristics of students inclined to write a higher number of posts, or good quality posts. Also, to our knowledge, no proposals have been made in the literature in which blogs are used to publish LL generated by students.

III. A CYCLE OF LESSONS LEARNED FOR PROJECT-BASED LEARNING

Fig. 1 represents the LL-related roles performed during the development of a learning project. These roles fit the LL stages identified by other authors [17]. The role of LL broadcaster is important during the project initiation stage. The activity to be performed involves selecting a set of interesting LL for the project and sharing them with the student teams. It is therefore convenient to know the LL repository and anticipate which contributions will be related to the project. This role should be played by an instructor involved in the course in previous years and with some experience in the supervision of educational projects. The first year PBL is implemented in the course, the absence of LL can be compensated by some pseudo-lessons created by the instructors. During the execution of the project, unforeseen problems may arise that have to be solved. Some already available LL could provide an answer to the problem, so any student in the team can play the role of LL finder. Both in the sharing and finding of useful LL, it is important that the stakeholders read them in a reflective way. In the case of dissemination, the stakeholders will be all the students of the class, while after finding an LL, these will be the members of the student's team. Performing properly the role of LL reader is difficult when the workload is high. Some students may pay little attention during the reading and thus lose the benefit of the LL. In the case of teacher-mediated sharing, the reading activity may be accompanied by questions about the content of the LL to motivate understanding. These questions may carry some small weight in the course grade. It is also interesting that students reading the LL assess its usefulness. Therefore, we suggest that lessons created by peers be assessed, usually from previous courses. Peer assessment is a widely explored teaching method that exerts a very positive influence on learning [34]. In our case, the activities of reading, assessing, and testing the understanding of LL are carried out by way of Google Forms in sessions of about fifteen minutes where a maximum of four LL are read.

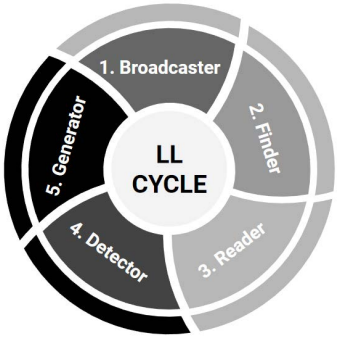

FIGURE 1. Roles found in the LL cycle associated with PBL.

The most difficult role is perhaps that of LL detector. Performing this role effectively requires reflection on what is being done and how it is being done. Students find it difficult to discern between what is an LL and what is not one. The activity of reading and assessing LL written by peers improves this understanding. The instructor should review the LL proposals (abstracts) and select those that are interesting enough. The last role would be that of LL generator or writer. Once the interesting ideas have been identified, the instructor invites the students to write the complete LL for later publication (in our case, in the blog). In our case, the LL written by the students comprise a title, the author's name, the date of the contribution, and a few paragraphs, including links to interesting web pages. In addition, they may contain illustrative images or a video that extends the lesson. Some studies detect difficulties with written language among students [35], thus, it is advisable for the instructor to provide some supervision in order to simplify the subsequent reading of the LL and clarify their messages.

Our experience applying the previous cycle allows us to identify some types of LL. The technological ones usually suggest technologies to solve problems that may be encountered and also their positive or negative effect. For example, software related to video creation, web site configuration, etc. Methodological LL usually suggest the steps to follow to achieve quality results. For example, how to write good video scripts, how to subtitle videos, etc. Organizational LL are about how to distribute and control teamwork. Some examples have to do with the collaborative writing of documents, inescapable tasks of the director, appropriate means of communication for collaboration, etc. Legal LL are related to the publication of materials (products) on the Internet. Some examples would be when to acknowledge authors of materials integrated in the products, license incompatibilities, suggesting free material repositories, etc.

Creative LL suggest alternative ways of creating materials. For example, animation of hand-drawn images, new ways of presenting prototypes of the product to be developed, etc. Lastly, there are LL related to security. For example, how to back up websites, how to send passwords securely by email, etc.

We also identified some common reasons for rejection. The first is proposing very obvious LL. These are usually very simple or well-known ideas or advices, for example, that it is not a good idea to use the chat to make a complex decision. The second reason is proposing something incomprehensible, probably caused by writing too fast or without sufficient reflection. The third reason is proposing something with little content, which could perhaps be part of a more general lesson, for example, one of the steps of a methodological lesson. The fourth reason is proposing a lesson that already exists in the LL repository. The last reason could be provided by a lesson that explains personal learning and may include concepts already covered in the course materials and activities.

IV. METHOD

A. PARTICIPANTS AND PROCEDURE

The LL cycle discussed in the section above has been applied in a project management course, the third year of a Computer Science Engineering Degree, for several years. A spiral of four learning projects is carried out in the course [34]. In three of them, it makes sense to apply the LL cycle (one of the projects is too simple and brief for LL to emerge). The first two projects last three weeks each and are done by teams of three or four students. LL detection and proposal are done at the end of each project. When both projects are complete, LL accepted by the instructor are written. The last project lasts eight weeks with teams of about seven students. This project follows the LL cycle as described in the previous section. The blog (http://projectknowledge14.blogspot.com) we use to publish LL is public and receives more than 8,000 visits per year, which means that the articles written by the students are of some interest to Internet users.

B. MEASUREMENTS

During the teaching of the subject in the courses from 2018 to 2021, measures of student activity were collected in an attempt to answer the research questions posed in this work. Each academic year, the number of students who followed the course and the number of LL proposed were counted. It was also identified how many of the LL proposals were rejected, accepted, and published. In addition, some student scores were collected, all of them between 0 and 10. Specifically, the proportion of correct LL questions about the contents of the LL read (all the questions have four options and only one correct), the proportion of correct questions about the monitoring of activities of the course and its projects (of the same type as the previous ones), the weighted average grade of the four projects (representing the 15%, 20%, 25% and 40% respectively), the grade obtained in the exam of theoretical concepts and the final grade of the course combined between projects and exam (45% and 55% respectively). LL count for an additional 10% of the grade on each of the three projects that include them. The average assessment of LL proposed for reading (each lesson is rated between 1 and 5) is also included.

For each student, assessments of their peers' work and her or his own self-assessment were collected for each project (between 0 and 10). From these assessments, the following four measures were calculated: From these assessments, the following four measures were calculated for each student: (1) the average assessment given by a student to all his or her teammates in the projects, (2) the average self-assessment of a student in the projects, (3) the average assessment received by a student from all her or his teammates and, finally, (4) the average assessment of all the members of the project teams in which the student participated (including the self-assessments of all of them). It should be clear that these ratings among students are not grades included in the evaluation of the subject, but data gathered in order to ascertain the quality of their interaction during the projects.

On the other hand, the students of academic year 2021 were asked for their opinion (a value between 1 and 5) about their perceived learning by reading LL, the influence of reading LL on the products they made, their satisfaction with reading LL, the difficulty involved in generating LL, and their satisfaction with generating LL.

C. DATA ANALYSIS

The ANOVA test was utilized to verify whether there were differences among three sets of data, and in that case, each pair of these datasets was compared using the Bonferroni correction to reduce the chances of obtaining false-positive results, because the probability of identifying significant results due to chance increases as more hypotheses are tested. Parametric conditions were checked beforehand to use these tests. When parametric conditions were not verified, the corresponding non-parametric tests (i.e., Kruskal–Wallis test) was also acceptable. The statistical software package SPSS v.26 was used for analysis.

V. RESULTS

In total, 162 students followed the method proposed in this research, including 140 males and 22 females with homogeneous ages between 20 and 22 years and whose race was almost exclusively European American; White.

Table 1 shows the number of students and the number of LL proposed, rejected, accepted, and published for each academic year analysed. It can be seen that the average number of proposals is close to the number of students. It should be considered that there will be students who do not propose any LL and others who propose several. It can also be seen that on average slightly more than one third of the proposals are accepted (38.3%) and slightly less than one third of the proposals are published (31.2%).

TABLE 1. Number of LL proposed, rejected, accepted, and published in each course analysed.

Course	Students	LL proposed	LL rejected	LL accepted	LL published
2018	24	17	10	7	7
2019	48	48	32	16	14
2020	39	39	16	23	16
2021	51	50	37	13	11
2018-21 (∑)	162	154	95	59	48
2018-21 (%)	–	100%	61.7%	38.3%	31.2%

TABLE 2. Students' opinions (from 1 to 5) on LL-related activities.

LL activity	1	2	3	4	5	Mean(st. deviation)
Learning by reading LL	0	3	14	26	8	3.76 (0.79)
Influence of reading LL on products	0	0	3	32	16	4.25 (0.56)
Satisfaction with LL reading	0	1	11	20	19	4.12 (0.82)
Difficulty generating LL	0	2	14	23	11	3.86 (0.81)
Satisfaction generating LL	3	6	20	14	8	3.35 (1.07)

Table 2 shows the results of students' opinion regarding the use and generation of LL. The opinion on learning by reading LL is positive (about four points on average and less than one point of standard deviation). The opinion on the influence of reading LL on products made is very positive (more than four points on average out of 5) and quite uniform (standard deviation close to half a point). Satisfaction with LL reading is also very positive (more than four points on average and less than one point of deviation). On the other hand, the activity of identifying and generating LL is perceived as a task of relative difficulty, although satisfaction generating LL remains positive on average with about one point of standard deviation.

Table 3 shows the comparison of means of the grades obtained in the course among students who did not propose LL, those who had all their proposals rejected and those who succeeded in having some LL accepted. It can be seen that in five of the six measures presented there are significant differences between the three groups of students. In the case of the assessment of a set of LL (written by students from previous courses), no differences are found among the three groups of students. In the assessment of questions on LL read and questions on monitoring of the tasks being carried out, after Bonferroni correction, the differences between the group with acceptances and the group that did not make proposals were maintained. In the case of the individual projects grade, the differences between the three groups persist after Bonferroni. Finally, in the grade of the exam on theoretical concepts and in the final grade of the course, after Bonferroni's correction, the difference between the group that had some acceptance and the other two groups is maintained. Finally, Table 4 shows what happens with the students' assessments of their teammates' work, and of their own, at the end of each project with respect to the same three groups (those who achieved some acceptance, those who obtained only rejections, and those who did not propose anything). It is observed that there are no differences among the three groups with respect to the average assessment of teammates. However, there are differences in the average assessment assigned to themselves in the projects (Self), in the average assessment received from teammates and the average assessment assigned among all the members of the teams in which they have participated. After Bonferroni's correction, differences were maintained in the evaluation received from teammates between those who did not make proposals and those who did. Differences were also maintained in the joint evaluation issued by the teams between those who did not make proposals and those who achieved some acceptance.

VI. DISCUSSION

In relation to the first research question, "What is the students' opinion about reading LL written by others and their practical usefulness?", the results obtained show a positive or very positive opinion with respect to perceived learning, its influence on learning projects, and satisfaction with the activity. These results coincide with those of other experiences. In the context of LL, it was found that the majority of employees in one study recognized the learning achieved by reading LL [14]. Other studies also note the positive influence of LL on project execution and the products obtained [3], [4], [14]. Educational experiences with blogs usually focus on the benefits students receive from writing. However, in an experience with a blog created by the instructor, a rather low number of visits was observed [29], suggesting the need to encourage their reading. We have not found similar educational experiences with LL.

The second research question is "What is the students' opinion about detecting and generating new lessons?". The results indicate that they encounter some difficulty and are moderately satisfied with the task, but less satisfied than with reading. In the literature, we find works that highlight difficulties in writing LL due to the time and effort required [14], suggesting the need to encourage this activity. Other authors mention as sources of difficulty lack of time or low value detected in existing LL [2], [19]. It has also been observed, in this same context, that employees prefer consulting and reading LL than writing them [14], which is consistent with our results on satisfaction between both activities. As for the experiences of writing blog posts, students are generally satisfied with the activity [26], [32], [33] consistently with the result obtained. Regarding the number of LL proposals received, in our case it is close to one per student, and considering the LL published, these would be over one lesson per three students. However, in a similar experiment with wikis, only one LL was received for every eleven participants [14], thus, the application of the LL cycle we are evaluating would give rather better results in the educational environment.

TABLE 3. Mean (standard deviation) of grades and valuations for each student group.

Assessment	No proposals	All rejected	Some accepted	Statistic	After Bonferroni
LL assessment	3.60 (0.39)	3.74 (0.41)	3.68 (0.45)	n.s.	
LL questions	7.99 (1.24)	8.43 (1.09)	8.63 (0.90)	H=16.814*** p<.001	Some accepted>No proposals
Monitoring	5.95 (1.57)	6.47 (1.33)	7.16 (1.41)	F=8.971*** p<.001	Some accepted>No proposals
Projects	7.00 (1.14)	7.49 (1.02)	8.42 (1.15)	H=36.916*** p<.001	Some accepted>All rejected> No proposals
Exam	7.15 (1.55)	7.41 (1.19)	7.75 (1.55)	H=8.649* p=.013	Some accepted>All rejected, No proposals
Final grade	6.93 (1.44)	7.37 (1.09)	7.88 (1.58)	H=22.830*** p<.001	Some accepted>All rejected, No proposals

Statistic: ANOVA or Kruskal Wallis, *p<.05, **p<.01, ***p<.001

TABLE 4. Mean (standard deviation) of grades issued by students in the team for each student group.

Assessment	No proposals	All rejected	Some accepted	Statistic	After Bonferroni
To teammates	7.75 (0.86)	8 (0.81)	7.95 (0.79)	n.s.	n.s.
Self	7.76 (0.84)	7.93 (0.77)	8.11 (0.73)	H=4.309*, p=.038	Some accepted>=No proposals (lost)
From teammates	7.75 (1.10)	7.98 (0.74)	8.23 (0.78)	H=16.527***, p<.001	Some accepted, All rejected>No proposals
Teams	7.68 (0.55)	7.90 (0.43)	7.96 (0.45)	H=11.210**, p=.008	Some accepted > No proposals

Statistic: ANOVA or Kruskal Wallis, n.s. no significant, *p<.05, **p<.01, ***p<.001

Regarding the third and last research question, ''What is the profile of the students most likely to detect and generate LL of sufficient quality?'', the results show that they tend to be students with good instructor grades (brilliant) and that they do a good job in the subject (they are more attentive). As to peer assessment, their teammates see them as good collaborators and they themselves are aware of this. Moreover, they participate in teams with good self-assessments. Regarding LL reading, they understand them better than others but assess them in a similar way. On the contrary, those who do not propose LL tend to obtain the worst grades from the instructor, have the worst course monitoring, obtain the lowest assessments from their teammates, participate in the teams with the worst self-assessment, and understand the LL reading worse than the rest. It is difficult to find in the literature results that are really comparable to those we have just explained. For example, in a study on participation in discussions made through comments to blog posts, it was observed that more participative students were associated with those who obtained better grades [33]. Ignoring the obvious differences, this resembles our first result, i.e., students with better quality participation (LL accepted) tend to get better grades. Regarding peer assessment, we found different studies observing its positive impact on learning. However, we have not found studies that relate teammate assessments with quality contributions in social media.

VII. IMPLICATIONS OF THIS STUDY

The first implication of this study is that it makes sense to incorporate an LL cycle into PBL practice and that the ensuing benefits are clearly perceived by students. The second implication is that new LL of interest can be expected to come from the most active and motivated students. However, instructors are expected to stimulate and encourage LL by selecting and disseminating appropriate LL, introducing variations in the type of product to be developed or its requirements over the years, advising LL proposers, and making quality LL public, in our case on a blog.

VIII. CONCLUSION, LIMITATIONS, AND FUTURE WORK

In the context of project management, LL are contents that bring undoubted benefits to project performance. Although some authors have applied this concept to educational projects (PBL), apparently no one has tried to reuse LL from previous experiences, thus missing out on their potential benefits. This paper has analysed the application of an LL management cycle associated with PBL in an educational context. The results obtained indicate that reading LL created in previous courses helps students to learn, has a very positive effect on the results of their work, and is a pleasant activity for them. Students understand that creating new LL entails some difficulty, although they find it a moderately satisfying activity. Finally, students most predisposed to creating quality LL tend to be brilliant and their work tends to be well considered by their collaborators and themselves. They also perform better monitoring of class activities and have a better understanding of the LL they read, although they value them in much the same way as their peers. The implications of these results are that lesson generation is well suited to project-based learning and that students generate an interesting number of quality lessons with the instructor's support and encouragement.

This research has several limitations. Although the sample size used is generally considered sufficient for this type of analysis, additional studies in different university contexts, and with different and larger samples would be required to verify our results and conclusions before making broader generalizations. This study did not include any qualitative data

from advisors to strengthen the results. The combination of quantitative and qualitative data is an option to be considered in the future.

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