Classification of Lessons Learned Generated by Students in the Practice of Project-Based Learning

Arturo Jaime, José Miguel Blanco, César Domínguez, Imanol Usandizaga, and Rosa Arruabarrena

***Abstract*— Some project-based organizations report and share knowledge through lessons learned in order to improve performance in future work. The objective of this study is to test whether the use of this technique, in Project-Based Learning, is sustainable over time. Also, it is interesting to test what are the types of lessons generated most frequently, whether they have interest for the learners, and whether the activities involved are satisfactory for them. The research is carried out by incorporating the lessons learned technique into a Project-Based Learning experience over several years. The methodology consists of the analysis and classification of lessons, published in a blog, and the data collected about the students (grades and opinions). The results show that technological lessons are the most numerous and visited, followed by methodological lessons in terms of generation, and work organization lessons in terms of visits. Moreover, the opinions of the students are very positive in all activities related to the dissemination, generation, learning achieved and usefulness of the lessons in a fairly unanimous way. In conclusion, the lessons learned technique serves as a good complement to reinforce Project-Based Learning, enabling students to acquire knowledge, perceive its practical usefulness, and express satisfaction with the activities involved.**

***Index Terms*— Project-Based Learning, lessons learned, student generated contents, peer learning.**

I. Introduction

LESSONS learned (LL) are the collection of knowledge gained from experience in project development, both from successes and failures, in order to improve performance in future work [1], [2]. These lessons can be incorporated into all types of projects, including those developed in the Project Based Learning (PBL) methodology. PBL is a project-based learning method in which students plan and evaluate projects that have real-world application beyond the classroom [3]. PBL typically involves a team of students developing a formative project in which they learn one or more concepts. The project culminates in the presentation of a product or solution. Unexpected problems may be encountered along the way, and correct decisions may have been made on some occasions, and wrong ones on others, which could be of interest in future projects. The knowledge acquired by students can be applied and projected into the future, encompassing various types such as technological, methodological, and organizational. One way of documenting such knowledge is through the generation of LL by the students involved. Therefore, the introduction of lessons in PBL involves the management of student-generated content [4]. These lessons can be published in different formats such as mini-articles, videos or questions with answers [4], [5], [6].

The present work is an extension of the article presented at the JENUI 2022 conference [7], where it was selected as one of the best submissions. In this new paper, the basic classification of LL types, included in the previous paper, is deepened and extended. In addition, a study is made of the generation of LL of each type and the visits they have had over time. Data from a new academic year has also been included, updating the results and comparing the opinions of three types of students based on their engagement in LL generation. These types include students who have generated LL that were accepted by the instructor, students who have generated LL that were not accepted, and students who have not engaged in LL generation. The initial hypothesis is that the generation of LL leads to greater learning and satisfaction in those students who have generated LL with respect to those who have not.

The article begins with a brief review of the use of LL in the entrepreneurial world and in education (Section II). The organization of motivation, dissemination, collection, review and publication of LL is then presented in two project management subjects called Computer Science Projects and Project Management of the Degree in Computer Science at the University of La Rioja and the University of the Basque Country, respectively (Section III). Next, a classification of LL, elaborated from those collected since 2014 in those subjects, is provided (Section IV). Later, the results of quantifying the lessons of each type generated over time are presented, along with students' opinions regarding LL-related activities and their academic results (Section V). Finally, the findings are discussed and interpreted (Section VI) and some conclusions are drawn from the experience (Section VII).

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II. Project Lessons

LL have been used in some companies and organizations to collect the knowledge acquired by project developers. The objective is to record those aspects learned that have contributed to both the success and failure of the project, in order to be able to improve performance in future work [1], [2]. The goal is to disseminate this knowledge within the organization and promote learning among its members. To manage LL, these organizations often use knowledge management systems [2]. But capturing LL presents difficulties, usually due to lack of time, and in many occasions the knowledge disappears when team members leave the organization [1], [2]. Moreover, it seems that more effort is put into identifying LL than into disseminating them [2]. It is clear that LL processing does not end when they are captured, but that their usefulness lies in applying them in subsequent work. However, it seems that the main cause of the failure of knowledge management systems is the poor dissemination and application of LL [1], [2].

Among the main keys to success in collecting and disseminating LL are the culture and structure of the organization [1], while difficulties include lack of time, perceived value, or cultural acceptance among many others [1], [2]. The ideas about LL can be applied to project-based learning if one understands that a subject is, in a way, like a small organization. In this case, there is an added difficulty: the outstanding members of the teams only stay in the subject for one year and, therefore, the knowledge they have acquired will disappear if it has not been captured in a format that is easy to transfer to others. It will also be important that faculty make an effort to encourage students to identify and propose LL, an effort to give them value by suggesting improvements and helping in their writing and, finally, an effort to disseminate them to students in successive courses, since the faculty will be the only effective link with previous courses.

In PBL, the goal is to learn while performing tasks that involve research and application of resources [8]. However, as in the case of projects in organizations, the experience leads to successes or failures that could enlighten future students developing similar projects. Some authors suggest introducing LL into PBL activities [6], [9]. For example, interesting LL could be those that explain errors in understanding concepts, organizational problems of the work team, or those that suggest interesting chapters, books or training videos, examples or exercises with outstanding difficulties, web pages or computer tools that help in performing tasks or understanding concepts, etc.

The use of knowledge and skills collected in LL is a form of peer learning [10]. Studies reflect that these methods can significantly improve academic performance. In addition, LL are student-produced content. One study observed that university students produce good quality content when they are guided by the instructor and work collaboratively [11]. This is a common situation in the PBL practice. In general, students who carry out this type of activities end up being adequately formed, are satisfied with the experience [4], [11], and consider that the materials generated help them to learn, despite perceiving a certain degree of incorrectness in the materials [4]. There are several peer learning proposals that involve content created by students, such as wikis [12], blogs [5], videos [13], test questions [4], [14], or our case of LL [6].

III. Incorporating Lessons Learned Into Project-Based Learning

The organization of the proposal, writing, and distribution of LL created by students will be explained now. The experience has been reconfigured since its initial implementation in 2013 in two project management subjects known as Computer Science Projects and Project Management of the Degree in Computer Science at the University of La Rioja and the University of the Basque Country, respectively. The practices of the subjects were developed as a spiral of projects (four in total) where each project builds upon and expands what was learned in the previous ones [15]. The projects aim to develop websites, video channels and their contents (videos, selection of linked articles or questionnaires) as products.

Difficulties inherent in the process soon emerged when collecting LL after the completion of each project. It became apparent that students had difficulty understanding the purpose and nature of LL. This was evident when reviewing the ideas contributed by the students, as many did not meet the criteria of LL. Additionally, there were LL that had not been identified as such or were expressed in a way that made them difficult to comprehend [16]. Despite these challenges, some of the LL presented could still be considered interesting.

Initially, mandatory LL were requested for each project, but it was observed that most of them lacked sufficient reflection on the tasks performed. It became clear that understanding what constitutes LL, identifying them, and articulating them effectively posed challenges, which made it necessary to reconsider the initiative and its objectives.

A. Format and Publication of Lessons Learned

The LL written by the students have a title, the author's name is highlighted, and the date of the contribution is provided. They usually consist of a few paragraphs, including links to interesting web pages. They may also contain illustrative images or a video that extends the lesson.

The LL are published in a blog entitled Project Knowledge 14[1] where there are several sections that classify them by language. While most of the LL are written in Spanish (128), there are also some in Basque (56), and even some in English (5). The blog includes a search engine and a subject index. Up to November 2022, the blog has received more than 68,000 visits. Figure 1 shows a graph of visits over time. The peaks observed coincide with the time authors' subject is taught and become more prominent from 2017 onwards. The more pronounced peaks in 2017 and 2018 may be attributed to the interest generated beyond the subject on the Internet for some specific lessons. Most visits have been from Spain (69%), with aditionals visits from the United States (7%), Ireland (5%), and Russia (4%). The three LL with the highest number of visits are entitled "License on youtube and on video, which in stronger?" (2,380), "How to make a quiz from a question

[1] projectknowledge14.blogspot.com

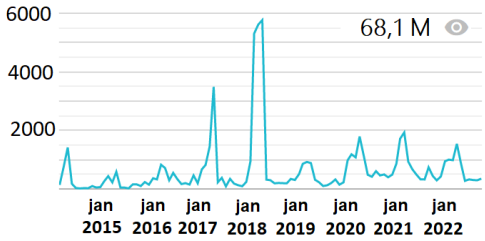

Fig. 1. Blog visits over time.

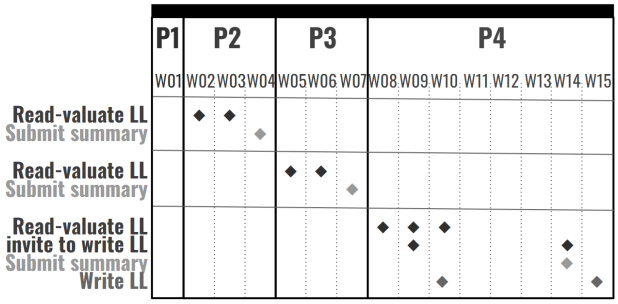

Fig. 2. LL in projects P2 to P4.

bank with ClassMaker" (1,980), and "Fixing time intervals properly" (1,480). Considering the number of visits received, it is evident that these topics generate interest among Internet users.

B. When and How Lessons Learned Are Proposed

After recognizing the challenges students faced in understanding, identifying, and writing LL, and acknowledging the lack of instructors' capacity to handle a high number of LL proposals, four decisions were made. Firstly, LL proposals would become *optional* assignments, designed to enhance project grades. Secondly, they should be *individual* assignments, allowing students to submit multiple LL per project. Thirdly, before writing the final version of the LL, the student should have submitted a summary of the idea to be developed and the instructor should *approve it*. Finally, depending on the ideas received in the initial projects, the instructor should *suggest ideas* or challenges, which could be converted into a LL, that a student could address.

With these considerations in mind, and as shown in Figure 2, several points in the course were planned to manage LL proposals. In the closing processes of the second and third projects, students were asked to voluntarily submit *abstracts* of their LL ideas individually. The instructor provided brief feedback, including a label indicating the type of rejection or acceptance, along with a numerical grade. At the beginning stage of the fourth project, the most ambitious of the course, the instructor *invites* those students who have proposed promising LL ideas to further develop them. On quite a few occasions, the opportunity is taken to make suggestions and motivate them to complete the LL, for example, by explaining why the idea would be novel or interesting. This activity is postponed to the fourth project due to the workload associated with completing previous projects. Final proposals are considered for publication on the blog. Often, instructors provide input in the writing of the final version, in order to enhance readability. Finally, at the closing stage of the last project, summaries are collected again, either at the invitation of the instructor or the team's project manager. Eventually, the instructor *invites* students to write new LL. As this is a period of the course with a higher concentration of learning tasks, generally fewer LL are written compared to the beginning of the fourth project. The course grade is divided into 55% for written exam and 45% for project deliverables (practical grade). The LL are compiled in three of the projects, accounting for 0.1, 0.15, and 0.2 extra points respectively towards the practical grade. To pass the course, students are required to obtain 5 points out of 10 in both written exam and project deliverables.

The number and quality of LL proposals may decline over time. To avoid potential saturation, changes have been introduced in terms of the type of product (videos, channels, blogs, websites, quizzes, links to articles...), technologies used (YouTube channels, Vimeo, WordPress, Sites, blogspot...), and subject matter (IT security, IT and sustainability...).

C. Selection and Evaluation of Lessons Learned

In addition to the initial difficulties observed in students understanding of what a LL is, when they were presented as an optional activity, the authors noticed a lack of motivation in reading, proposing, and writing them.

To address this situation, the approach considered was to make LL from previous years more accessible to the students. Authors understood that limiting themselves to showing the LL blog, giving a reference to it, was insufficient. Therefore, class time was dedicated for students to engage in selected LL readings. The beginning phase of the projects was found to be an ideal moment for these readings. Three or four LL closely related to the upcoming project were chosen to increase their interest.

Furthermore, the authors decided to incorporate an evaluation form for the LL readings, that is, to introduce peer evaluation of LL. This peer review system had given them very good results with the products (videos, websites, video channels...) created by other students within the same course, showing statistically significant improvements in the quality of the products presented [15]. However, two key differences arise when it comes to LL. Firstly, LL being reviewed are made by students from *other courses* who are probably unknown to students performing the evaluations. Secondly, the evaluation focuses on a written mini-article format. Since there are many students who are reluctant to read texts, the authors incorporated some questions on the LL content into the review form to motivate them to read carefully. As shown in Figure 2, LL review activities from previous courses were conducted during the initial phase of projects 2 to 4.

Obviously, during the early years of implementing LL creation, it is not possible to have LL from previous courses to read and evaluate. However, this lack can be overcome by providing examples, given by instructors, that highlight foreseeable difficulties in project development.

D. Rejected and Accepted Ideas

LL proposals are typically rejected when the concept has not been well understood, indicating that what is submitted is not a true LL or lacks sufficient entity on its own. Throughout the years, consistent reasons for rejecting proposed ideas have been observed. Despite discussing these reasons in class sessions to minimize failures, they still occur to a considerable extent. The following primary reasons for rejection have been identified:

1. *Very obvious*: Suggestions or ideas that are commonplace or already widely known, for example, *holding meetings via chat is a bad idea*.
2. *Gibberish*: Proposals that cannot be understood despite several careful readings.
3. *Little entity*: Typically, these are minor proposals that could be part of a more general LL. For example, *a good tool for translation is Deepl*.
4. *Already exists*: A similar idea, if not the same, has already been published as an LL in the blog.
5. *Personal learning*: In some cases, the writer acknowledges that he/she should have applied or known what he/she is discussing earlier. For example, *I have learned to synthesize my ideas*. In other cases, they explain a concept that has already been covered in theory, such as *the scope of a project includes*...

IV. Lessons Learned Classification

The classification of LL is important to facilitate three activities: to guide those interested to read the most relevant LL that meet their needs, to guide those contributors in documenting existing lessons related to the same topic when contributing new LL, and, thirdly, to analyze which are the focal points of interest and in which areas it may be necessary to promote new contributions.

Working with LL within the framework of the PBL methodology has allowed the authors to classify LL into six main categories:

1. *Methodological/Project management*. The first type includes LL related to the body of knowledge of the subject or methodologies associated with the proposed projects to be carried out in the subject. It consists of two subcategories. The first subcategory is related to *project management, involving*knowledge or techniques directly related to the subject's content. The second focuses on the methodology for *creating videos and other products*. Examples of methodological LL are explanations on hand-drawn video creation, animation using pre-made drawings, and prototype presentations. Such LL typically suggest the steps to achieve quality results, for example, when writing video scripts, recording scenes or audio, or acquiring materials elaborated by third parties.
2. *Technological*. This category covers techniques and tools to be used during the development of the projects' objective products. In the authors' experience, the products to be developed are websites of a certain complexity that incorporate multimedia contents. Technological LL are grouped into subcategories such as *Web hosting, Web, gadgets, WAI, development of videos and other products, and video hosting*. These LL often suggest tools to solve specific problems or explain their positive or negative effects. For example, LL may highlight unforeseen issues when using resources, such as free hosting alternatives, video creation, and so on. They may also explain hidden options of tools or offer solutions for overcoming their absence, such as contacting a video channel administrator.
3. *Legal aspects.* This category addresses legal considerations since the projects' published products utilize materials developed by third parties and are accessible on the Internet. Thus, it is important to be aware of legal aspects such as suggesting sites that offer information about licenses or sources for free-use images and music, requirements for handling personal data, and license compatibility.
4. *Work organization*. Lessons in this type explain how to undertake teamwork, distribute work, follow up on work or deal with problems that may arise in teamwork. Topics covered may include collaborative writing (templates, shared documents, version management...), the impact on work of different team roles, or useful infrastructure recommendations (for instance, communication tools...).
5. *Security*. This category encompasses LL that focus on security aspects, such as making backup copies with different technologies, securely sending of passwords, etc.
6. *Miscellaneous*. Finally, this category includes LL that do not fit into the previous categories, such as, for example, those related to the transfer to operation of an Internet product and its change of ownership account.

This classification can also help to transfer this experience to other subjects, taking advantage of those LL that are useful in other areas without the need to be duplicated.

V. Results

In subsection A an analysis of the data extracted from the blog where the LL are published will be presented. The blog has been shared since its creation by the subjects Computer Science Projects of the University of La Rioja and Project Management of the University of the Basque Country of the Degree in Computer Science. However, the data in subsections B, C, and D below correspond exclusively to students of the subject Computer Science Projects of the University of La Rioja, where opinion data were collected.

A. Types of Blog Lessons

As it can be seen in Figure 3, the addition of new lessons to the blog has remained, in general, constant over time. The exception is in the first year, when a set of lessons from previous courses was incorporated to give the blog a first boost. However, there has been a slight increase in recent years.

Taking into account the classification of LL from the previous section, Figure 4 shows that *technological* lessons are significantly the most numerous, followed at a distance by *methodological* and *work organization* lessons. Examining the subtypes, it can be observed that methodological lessons on *management* (34 lessons) and technological lessons on *creating videos and other products* (28) are very similar in quantity to the *work organization* type (32).

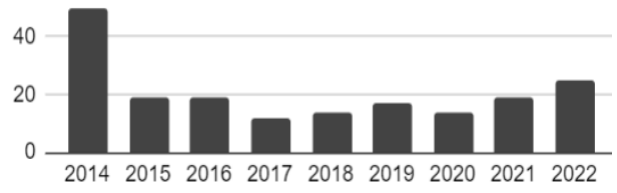

Fig. 3. Number of new lessons per year.

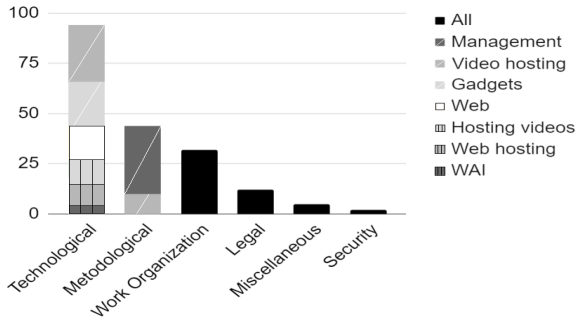

Fig. 4. Number of lessons of each type/subtype.

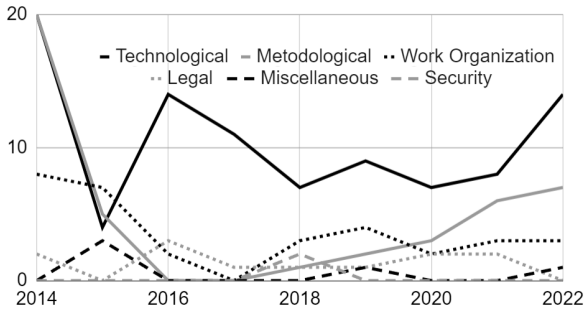

Fig. 5. Number of lessons of each type per year.

Figure 5 shows the number of lessons of each type added each year. Those of the *technological* type stand out from the third year onwards. There is also a considerable drop in *methodological* lessons in the third and fourth years and a sustained growth thereafter. Those related to the *organization of work* are maintained in most years above the other three types. The number of visits to each lesson has also been compiled. It should be noted that a good part of the visits reported in Figure 1 refer to the area of lesson summaries or auxiliary pages (those received for the latter are anecdotal). Figure 6 shows how most of the visits to lessons are directed towards those of the *technological* type (the most frequent).

It is remarkable that the second and third most visited groups are the *work organization* and *legal* lessons, to the detriment of the *methodological* lessons (second group in number of lessons), which are pushed back to fourth place. The success in visits of those dedicated to *work organization* may be attributed to the fact that lessons which help students organize teamwork within the groups conducting the projects (an essential aspect within the Computer Science Projects and Project Management courses) generate more interest among them. To interpret the success of the *legal* ones, further issues contained in the following figures need to be studied.

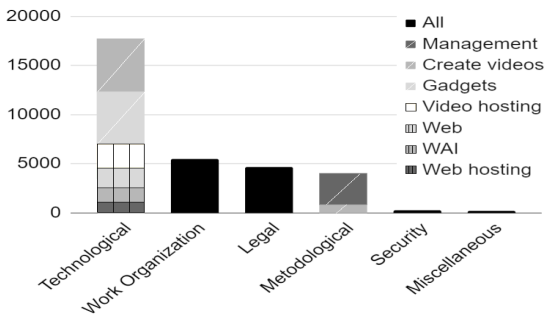

Fig. 6. Number of visits to each type/subtype.

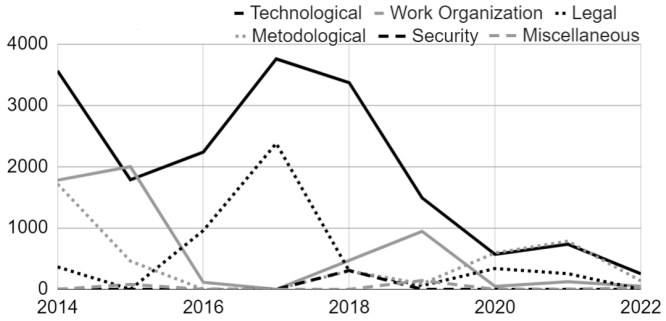

Fig. 7. Number of visits to lessons of each type generated each year.

Figure 7 shows the total number of visits to each group of lessons generated in each year. As expected, it can be observed that the lessons that have been published for a longer duration accumulate a greater number of visits. This is why more recently published lessons have fewer number of visits. *Technological* lessons published over the years consistently remain the most visited group. There is also a peak in visits to *legal* lessons in 2017, which coincides with the most visited lesson of the blog. The valleys observed depend on the number of lessons published each year. For example, the valley corresponding to the number of visits to *technological* lessons in 2015 corresponds to a lower number of lessons of this type published in that year.

Finally, the average number of visits per lesson in each group has been compared, as depicted in Figure 8. The influence of the most visited lesson, of *legal* type, is again observed. This, combined with the limited number of lessons in this category, places it as the type with the highest ratio of visits per lesson. Despite being much more frequent, the ratio of *technological* lessons is slightly higher than the others, although it is very similar to the average number of visits to *technological* (189), *work organization* (173) and *security* (154) lessons. When analyzing the ratio of visits per lesson over the years, a certain preponderance of *technological* lessons can be observed in some years, while other types stand out in different years. This pattern seems to depend on the interest generated by the lessons of each type in that specific year, without any type uniformly surpassing the others.

B. Lessons Acceptance Ratio

Figure 9 shows the number of LL generated in the 19-20, 20-21, and 21-22 academic years. The number of LL proposals

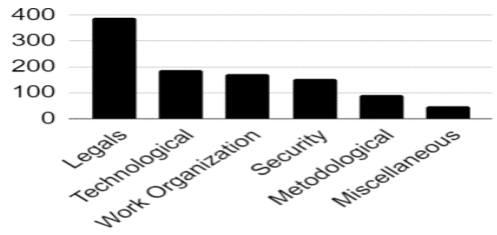

Fig. 8. Average number of visits per lesson for each type.

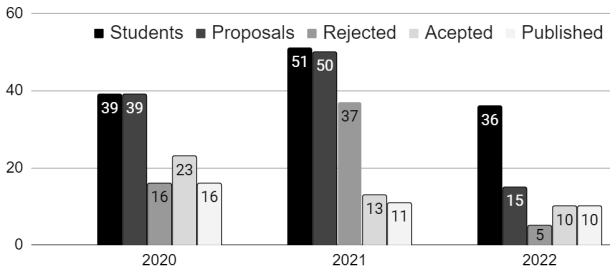

Fig. 9. Total number of LL proposed, rejected, accepted and published.

is high and is close in some courses to the number of enrolled students, while in others it is approximately one half. However, these numbers do not match the number of LL added to the blog in the same years. As previously mentioned, the data presented in Figure 9, along with the subsequent subsections, exclusively correspond to one of the two universities utilizing the blog.

It should be noted that some students propose several LL and others none, and that not all of them are accepted, with the percentage of acceptance, ranging from 26% of the proposals in academic year 21 to 66.6% in academic year 22, with an average acceptance rate of 50% throughout the studied years.

C. Student Opinions

The student opinion data was collected in the 20-21 and 21-22 academic years. A survey was conducted among 87 students enrolled in the course, asking them to rate five aspects of their experience with LL. The questionnaire received responses from 86 students.

The questions followed a Likert-type scale, ranging from 1 (a little) to 5 (a lot). Figure 10 shows a very hightly positive on both the learning achieved by LL reading and its practical influence on product development. Figure 11 suggests that LL writing is generally perceived as a task involving some difficulty. Figure 12 shows a high level of satisfaction with LL reading and a moderately positive level of satisfaction with LL creation.

D. Student Characteristics

During the 19-20, 20-21, and 21-22 academic years some objective data was collected on the activity of the 126 students (100%) who took the course. The analysis is shown in Table I. The purpose of the analysis is to gain an understanding of what type of student is more likely to propose LL and who is successful in publishing them. The results obtained by three groups of students are compared. The group labelled "No

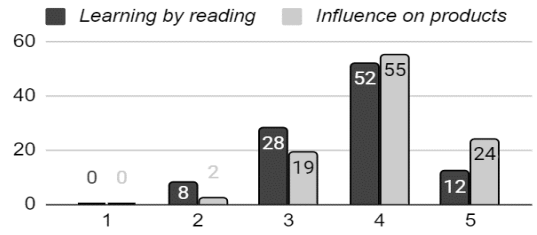

Fig. 10. Distribution, in percentage, of opinions on learning and impact on products.

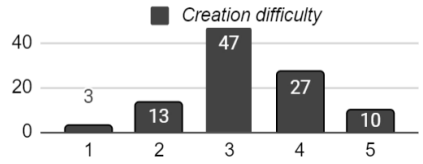

Fig. 11. Percentages of opinion on difficulty in writing LL.

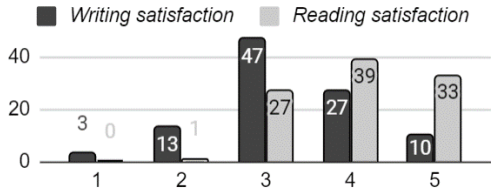

Fig. 12. Satisfaction percentages reading and writing LL.

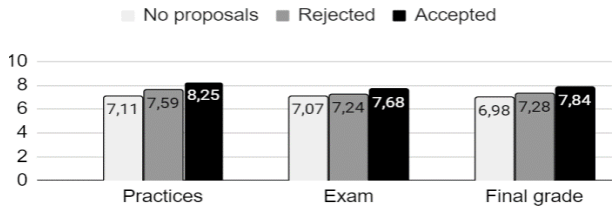

Fig. 13. Comparison of practices, exam, and final grades among those who didn't propose LL, those with only rejections and those who published LL.

Proposals" is made up of those students who did not propose any LL. The "Rejected" group is made up of those students who proposed some but did not achieve any acceptance Finally, the "Accepted" group is made up by those students who succeeded in publishing some LL.

Figure 13 shows the average grade in practical assignments, exam, and final grades of the course for each group of students. There are significantly differences between the three groups in the *practical grades*, where the projects and activities related to the development of the LL are carried out, in the *exam*, independent of those, and in the *final grade* of the course.

Table I also shows the median of the answers to the five questions explained in the previous subsection. No differences are observed between the groups with respect to perceived learning by reading lessons or in the influence of lessons on products. There are significantly differences in satisfaction reading or writing lessons, while there is only significantly trend in the perceived difficulty of generating lessons.

The group that is the most satisfied with the reading is the group of students who propose lessons without achieving acceptances. It is also the group that perceives more difficulty

TABLE I
MEAN (STANDARD DEVIATION); MEDIAN OF GRADES AND OPINIONS BY STUDENT GROUP

	No proposals	Rejected	Accepted	Statistics
N	59	34	33	
Practical	7,11 (0,97)	7,59 (0,92)	8,25 (1,10)	F=13,941*** p<0,001
Exam	7,07 (1,57)	7,24 (1,26)	7,68 (1,38)	H=6,528* p=0,038
Final grade	6,98 (1,33)	7,28 (1,17)	7,84 (1,38)	H=4,657* p=0,011
Learning by reading	4	4	4	n.s.
Influence on products	4	4	4	n.s.
Creation difficulty	4	5	4	H=5,252^{+} p=0,072.
Reading satisfaction	4	5	4	H=6,202* p=0,045
Writing satisfaction	3	4	4	H=8,257* p=0,016

Statistics: ANOVA or Kruskal Wallis $^{+}$p<0,1; *p<0,05; **p<0,01; ***p<0,001.

in generating lessons, although the latter is more understandable. In general, the group that is the most dissatisfied with creating LL is the group that does not propose any LL, an aspect that may have led them to decide not to suggest any.

VI. DISCUSSION

The classification of LL has revealed the strong interest of the technological lessons, both in their creation and in their subsequent query. The methodological ones are also of considerable interest, more accentuated in their creation than in their subsequent use. Students could perceive the need for technological solutions and seek them, probably in a reactive way, to be effective in solving problems. However, students do not seem to seek efficiency in the same way, trying to find the most appropriate steps to build the solutions. The latter, which characterizes methodological lessons, requires a more proactive attitude. It seems that motivating and publicizing the latter type of lessons should be a task for teachers.

The number of quality LL remains more or less constant over time, although occasionally there may be fluctuations. Variations are also perceived in the number of rejected LL. All these observations suggest that the instructor should motivate students in the generation of lessons, for example, by asking each team about their experience in the project and proposing the reading of interesting lessons [2], [4].

Regarding students' opinions on LL reading and assessment activities, it can be confirmed that they find the method used to disseminate LL satisfactory and of practical use in both projects and learning. They also perceive some difficulty in identifying and writing LL, a task they are quite satisfied with. These opinions contrast with those of employees in one company, who experienced difficulties in finding relevant information in knowledge databases and spent very little time on lessons, which did not quite fit into the culture of the organization. They experienced difficulties in capturing good lessons, in this case because the task was postponed too much [2]. Furthermore, the difficulties in generating LL, perceived by students, may be related to problems in explaining ideas through writing, as detected by some authors [16] and identified as one of the main reasons for LL rejection (gibberish or incomprehensible descriptions). However, students who generate content are usually satisfied with the learning achieved, including peer assessment [11].

Lastly, the grades and opinions of three groups of students have been compared: those who do not propose lessons, those who get some acceptance, and those who propose LL unsuccessfully. The expected result is that more quality lessons are generated by the students who achieve better grades, not only in the practicals (which include the points obtained for LL writing), but also in the exam (independent from LL) and the final grade. However, the opinions of these three groups seem to coincide (no significantly differences) regarding the high influence of LL on the products obtained, the high level of learning achieved, and the difficulty involved in generating them. The differences are centered on satisfaction, with those who propose LL being more satisfied (reading or writing LL) than those who do not propose LL. Additionally, blog visits during the course (Figure 1) suggest a certain level of student motivation to read LL. These results align with observations from experiences in which students generate content, where, regardless of the score achieved in completing exercises (created by peers), students displayed a very positive attitude towards the experience ("it is more interesting to learn by researching than just listening to the teacher") and exerted effort to create quality content [4].

VII. CONCLUSION

In this paper, LL are described as student-created content that fosters peer learning, primarily using materials generated in previous courses. Although these LL have been implemented in a project management course, the idea can be generalized to other PBL proposals, and could even be integrated into teaching methods beyond PBL.

Implementing LLs requires instructors to provide guidance and add value to the proposed ideas. This task demands effort, but leads to the emergence of very interesting ideas and discussions about the contents, competences and difficulties of the subject.

A review and classification of the lessons published over the years reveal that technological lessons are the most abundant and the most visited, and this trend remains consistent over time. Methodological LL rank second in number of generated lessons and, in terms of visits, work organization lessons come in second. Therefore, instructors should actively disseminate these last two types of lessons, which seem less tied to a reactive search for a problem, as observed in the case of technological lessons.

Students express high satisfaction with the reading (and the learning that entails) and the practical usefulness of LL. However, they also perceive the difficulty involved in creating them. Additionally, it has been observed that students who tend to submit quality LL achieve significantly better grades in the practicals, exam, and final subject grade. This suggests

that LL creators are often students who display interest in the subject and work diligently to attain good academic results. Moreover, opinions about LL activity are highly positive and consistent among all students, whether they propose lessons or not. One implication of these results is that the LL technique can be a valuable complement to reinforce PBL experiences.

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