Improving the development of engineering projects through informational competence and the introduction of social web tools

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Abstract

This paper describes the improvement plan conducted in the "Engineering Projects" course, aimed at increasing the quality of academic work in the preparation, writing and structuring of the course final documents.

The course is lectured in the last term of the degree courses at the Terrassa School of Industrial and Aeronautical Engineering of the Universitat Politècnica de Catalunya (UPC). The lecturers of this subject provide guidance and mentoring to the final degree projects, encouraging the participation and interaction of the students in an active way.

During the 2013-14 academic year, the following deficiencies were identified: lack of proper structure in the work, mistakes in bibliographic references, breach of copyright, low use of resources for the organization of information and lack of use of 2.0 tools. Therefore, a diagnostic survey was given out to identify the previous knowledge level which confirmed the existence of the above mentioned deficits.

The UPC Libraries have extensive experience in the acquisition of informational skills to improve the use, management and communication of scientific-technical information in the technical studies. Because of that a partnership with training purposes has begun in which the Library staff has participated in the lectures of the project's course. Many of these tools are Web 2.0 and social software.

The Web 2.0 concept has been introduced and its application in active learning activities for minimizing time and effort, has encouraged collaboration and communication and promoted both critical thinking and knowledge sharing.

During the academic year 2013-2014, the lecturers of the "Projects" course, along with library staff, jointly defined the goals for the improvement Plan, drew up a guide and developed teaching materials.

In the current academic year, the collaboration in the lectures is still going on. The members in charge of assessing the FDP (Final Degree Project) evaluate the progress all over the period using a rubric with criteria linked to the objectives of the collaboration.

1   Introduction

The Engineering Projects Department of Terrassa School of Industrial and Aeronautical Engineering (ETSEIAT) of the Polytechnic University of Catalonia · Barcelona Tech (UPC) offers, amongst others, the

compulsory subjects related to 'Projects' to undergraduate and graduate engineering students of the school. Such courses are done during the last year of the degree. Their objective is to give the students the necessary theoretical and practical knowledge in order to address the realization of any type of engineering project. During the teaching of these subjects, the students are compelled to acquire the notions and the capacity to use the tools involved in the definition and conceptualization of the project, as well as its management, alternatives evaluation and decision making relative to feasibility, considering the environmental component, together with the technical, economic and social feasibility analysis. Likewise the topics information management, documentation and teamwork in engineering projects are covered.

In the practical lessons of these courses, the students are divided into groups so that they carry out an engineering project. Also, as a part of their duty, they must produce the basic documents that constitute the project itself: drawings, memory report, technical sheets and budget. At the end of the course, they will have to defend their project orally. Thus, the students are required to acquire the knowledge and to learn how to use the appropriate tools for its accurate preparation and elaboration.

The objectives of such subjects contribute to the student's active attitude in class. Within the framework of reduced workgroups, students feel committed and connected towards a common project. That helps them learn autonomously and meaningfully, thus retaining what they learn longer. Participative learning is a permanent feature even in theory lessons, with a large expositive tradition. In this type of lessons, the lecturers, after a brief theory instruction, suggest an activity that is relevant to the taught contents. In that fashion, the students focus more on the lecture. Also, this technique eases the understanding of the concepts explained.

The collaborative work of these subjects becomes a realistic - as in real world - experience, as most of the students will spend a significant part of their career working as part of teams that pursue common goals. As a matter of fact, regarding the final work that each team must present at the end of the subject, the professors detected that the major flaws in the students' performance lie in the process of elaboration, composition and construction of the work.

Consequently, the Engineering Projects Department of ETSEIAT, in early 2013-2014 academic term, approached the Terrassa Campus Library (BCT) staff with this issue. UPC Libraries have a great amount of experience regarding the acquisition of informational know-how aimed at the improvement of the use, management and dissemination of scientific and technical information in polytechnic studies (Serrat-Brustenga *et al* 2011). It was agreed that BCT staff would participate in one of the theory lessons, in order to introduce resources and tools that might be useful for the project elaboration. A significant proportion of these are resources and tools from the Web 2.0 and social software - a compendium of innovative techniques developed in recent years. The title 'Web 2.0' assembles software tools that allow content creation and organization, evaluation of information produced by others and explains how to record, present and reuse it in new ways. All these applications are partly or fully Internet-based (*cloud computing*) and can prove to be useful along the elaboration, composition and defence of the project.

Because of this agreement, the Terrassa Campus Library, in collaboration with the faculty team responsible for the 'Projects' subjects at ETSEIAT, elaborated specific academic material for the students. This included a selection of resources and applications from the Web 2.0. The name Project 2.0 (Puertas-Molina *et al.* 2014) was given to this material, which is presented in infographic format (Figure 18). This type of graphical resource is very useful to bestow the information in an attractive and comprehensible manner. At the same time, it is easy to update. The objectives of such subjects contribute to an active attitude in class.
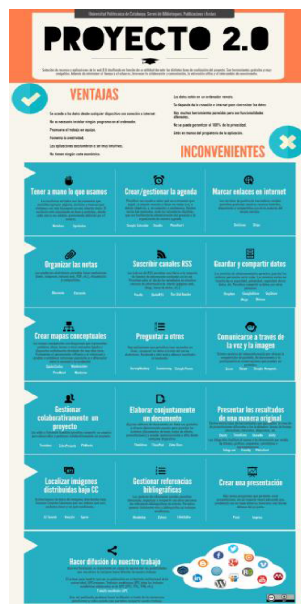
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Figure 18: Infographics

Although students usually handle technological and social network applications with ease (Cabrero, 2013), one cannot always anticipate this behaviour, whether in the social or academic background. (Gallardo, E. *et al.*, 2015). Scarce use of these tools is observed, especially, during the investigation, synthesis and composition processes. The same can be said about collaborative and communication tools.

First, the student accesses to and uses these resources because of the influence of his/her classmates. Second, professors do so on their own initiative, together with the project managers and the library staff (García-Ruíz, 2014). Students must develop new abilities to use them on their own, going beyond the simple use of digital tools. To achieve this, it is critical that the professor creates a favourable environment where teacher-student interaction is encouraged, shows successful techniques and offers technological resources that adapt to the student's needs.

After the first year of collaboration, both professor and students confirmed that all the proposed methodologies applied contributed to uplift the work. In general, the projects presentations have improved both in structure and quality, together with the citation of the consulted bibliography. The cooperation with BCT remained during the following year (2014-2015). Due to the interest in strengthening the 2.0 resources in all the elaboration process of the projects and in the knowledge itself stored within, the student body was surveyed before the collaboration. The results of this survey were used on a continuous basis to develop the courses. Also, they influenced how the 2.0 resources were introduced. The basics of ethical use of information and the academic work structure were presented, too.

2   Methodology

The Improvement Project started in the academic year 2013-2014. In total, 395 students attended the session given by library staff - 81% of the total enrolment. As indicated in the introduction, students were asked to complete a questionnaire (Questionnaire on the guidelines for preparing documents in Projects) and 112 responses (75 % participation ratio) were obtained (see **Table 3**).

Table 3: Attendee students in the Library session and

students who answered the questionnaire

	Enrolled students	Attendees	Answers
First term of 2013-2014	213	153	
Second term of 2013-2014	124	112	
First term of 2014-2015	149	130	112

From the beginning, the goals for both teachers and library staff were to get students to use the resources and recommendations for developing project documents following the guidelines set by ETSEIAT for preparing the Final Degree Project (TFG) and to promote reflection and critical thought of what they were doing. These key points of a strategy of active learning (Bonwell & Eison 1991) were achieved thanks to class discussions among the participants or the members of the working group. The students had to write down their ideas in the minutes of the meetings and give and receive feedback both in-class and out-of-class.

Projects in the subjects of active learning are introduced through cooperative work, one of the key strategies used in these subjects is organizing students into groups from the first day of class students work together in order to maximize their own and each other's learning. As in the professional practice, group members have different roles: coordinator, secretary, quality department, department of mechanics, etc. The groups are made up by teachers in order to provide equal opportunities to participate and feel included, because when students "self-select", then tend to do so based on their affinities. All group members must meet, keeping a record of all their actions (calls, meetings, agenda, etc.) on the BSCW platform (García-Almiñana *et al*., 2003) and they meet weekly in class, where the teacher can evaluate their progress or detect certain gaps.

Previous work suggests that one possible explanation for cooperative learning's success is that effective learning often occurs through an individual's interaction with his or her environment, and language is the means by which learning and meaning are made meaningful to the student (Tsay and Brady, 2010). Interaction with others enables students to make sense of what they are learning as they become responsible for articulating and discussing class content with their peers (Adams and Hamm, 1994). Having students do in - class role-plays – when skilfully designed and facilitated, is an especially effective active learning instructional strategy for (a) arousing student interest and engagement, (b)providing a realistic and relevant way for students to connect essential course content to their personal and/or professional lives, (c)teaching students to develop and apply critical thinking skills, (d) creating opportunities for knowledge transfer as well as developing deeper self-awareness and understanding, and (e) helping students develop increased empathy for others and valuing and respecting for cultural diversity.

The teacher-student out of class interaction has been conducted through the platform BSCW (Basic Support for Cooperative Work), tracking all conversations, minutes of meetings, process-related documents, etc. This communication flows parallel to that given in class, minimizes the risk of missed conversations or little participation from timid students who otherwise would not express their opinion.

Students are assessed using summative assessment. Teachers share a rubric with students where the issues the review panel will consider of their project are listed.

The rise in new digital media technologies and Web 2.0, smart classrooms equipped with online capabilities, and the use of course management tools and social media outlets, has changed cooperative learning as a pedagogical concept (Tsay and Brady, 2010). The proposed methodology for the implementation of resources 2.0 in the cooperative work of the project groups is set in this context.

In the first phase (first term of 2013-2014 course), an interview was conducted by three professors of engineering projects that teach the same subject in different degree courses. In a second phase of work, a survey was designed and resource uses 2.0 and attitudes toward new web technologies among students were documented. Knowing the needs and based on the regulation for the ETSEIAT, tutorial sessions of classroom presentation used jointly were prepared, as well. This presentation (Terrassa Campus Library, 2014) is available both from Athena, the teaching platform of the UPC, and from the space available on the Library SlideShare.

The constant referral to the responses collected in the questionnaire, during the session of the Library, led to the increasing student engagement as well as fostered critical / creative thinking.

3. Results

There is an agreement amongst professors to identify a number of obstacles in the implementation of active learning strategies. On the one hand, they can't cover as much course content in class with the available time. The fact of spending class time in the library session to introduce the 2.0 resources to be used in preparing their TFG has increased existing problems of time to achieve all the objectives set in the subject.

Another factor that has hampered the introduction of this strategy has been resistance by the student to participate and provide feedback. For the student, the role of passive listener is quite common and more comfortable than attending an exhibition class that does not form part of a less traditional activity.

The results achieved in the survey that was distributed among students are analysed. Figure 19 shows that in the organization of information for the project, most students use schemes (75 %), notes (67%) and abstracts (66%). It is noted that the use of other tools such as conceptual maps (37%) or summary tables, mostly associated with the application of 2.0 resources are still a minority.
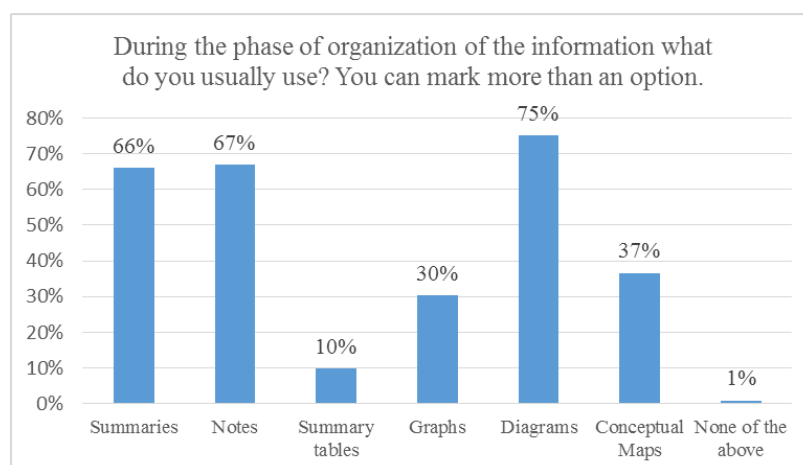

Figure 19 : Tools for organizing information

From the summary of the survey results shown in Figure 20, it appears that they are aware of the regulations related to intellectual property law, we also found that students raise serious questions about the ethical use of information when writing their work, and that 69 % still think they can use images regardless of license. These include images of others without indicating its source, phrases of others as of their own without using quotes, or paraphrasing without indicating authorship.
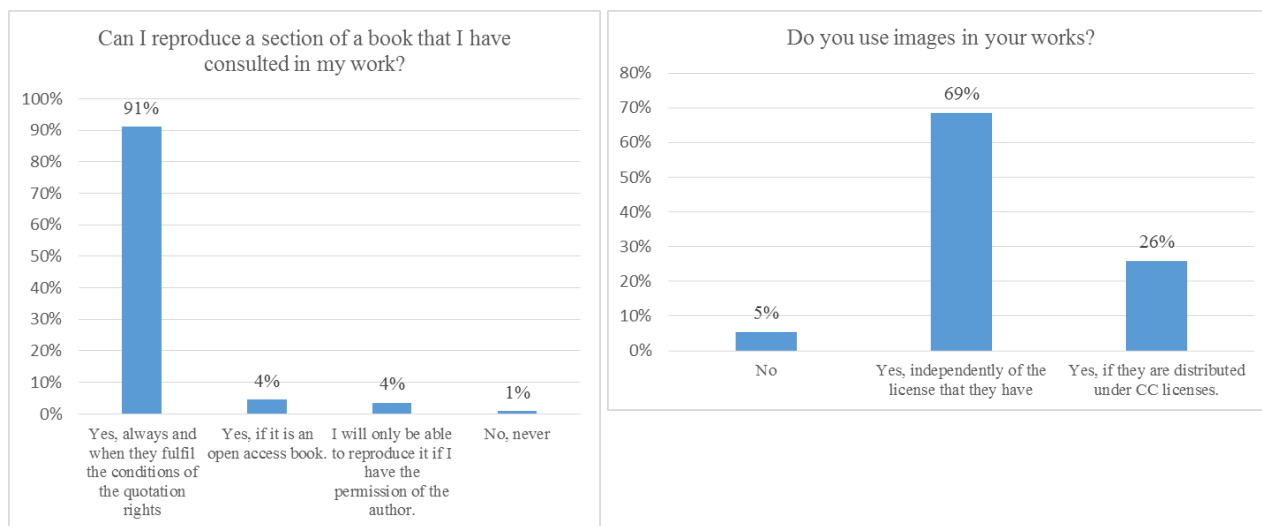

Figure 20 : Knowledge about intellectual property and ethical use of information

From the results, another relevant aspect is the limited use of reference managers and even ignorance of their existence (31 %), as shown in Figure 21. The students of these subjects had to successfully complete all three levels of "solvent use of information" skills. At the third level of the skill, the main objective is the introduction to the Mendeley Premium citation manager, which takes two hours of class and ten hours of virtual work with the obligation of submitting certain exercises and answering some questionnaires.
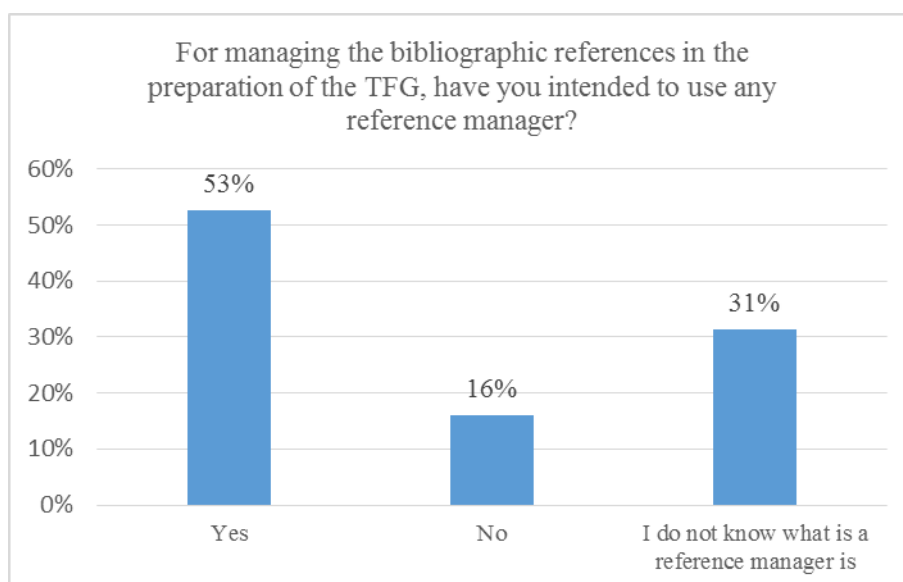

Figure 21 : Use of reference manager

Figure 22 shows that even 50 % of students think that they do not have ownership of copyright in the work or projects undertaken (48 % believe that it lies in the University and 2% in the tutor) . These works or projects have to be entirely developed by the student, despite having a tutor or director assigned. For this reason, it is the student who owns the rights under this creation.
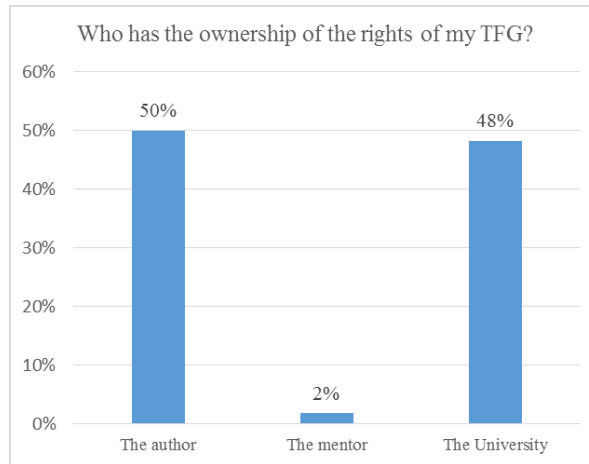

Figure 22 : Copyright in the work or projects undertaken by students

Therefore, the ownership of the intellectual property of the academic works directed or coordinated by UPC professors belongs to the authors (students) of the work. They are also the ones who can allow copying, distributing, publicly communicating, transforming and/or yielding the rights of exploitation to a third party. This issue encourages debate when discussing this issue at the session.

Most of the students, according to the results shown in Figure 23 have it clear that the work can't be published without permission (62 %), or when it violates the intellectual property rights (76 %), or when they have confidentiality agreements (65%). However, they seem to have more doubts in the case of patent applications.
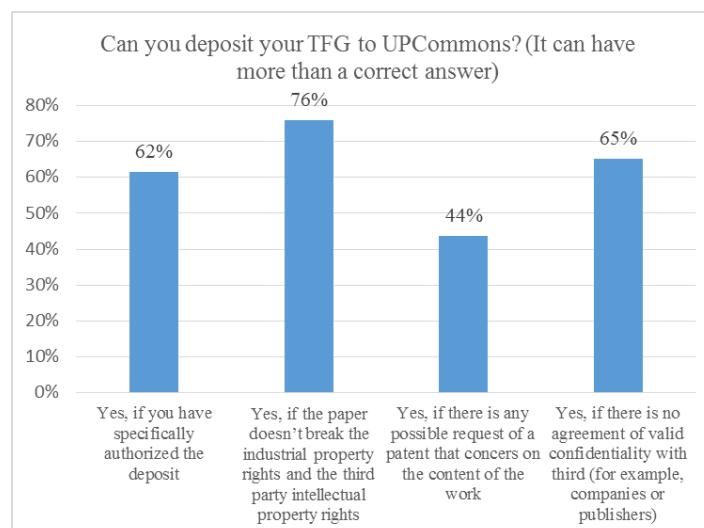

Figure 23 : Condition to publish under UPCommons

Figure 24 shows the limited use of the options that word processors are also offering. For example, only 14 % of respondents admitted to be using the automatic generation of summaries, a useful feature for the development of academic papers. Although the vast majority say that they are using the processor to review the typographical and spelling errors, more often than not the reviewing panel finds work with serious mistakes of this kind, even when considering just the title of the chapter.
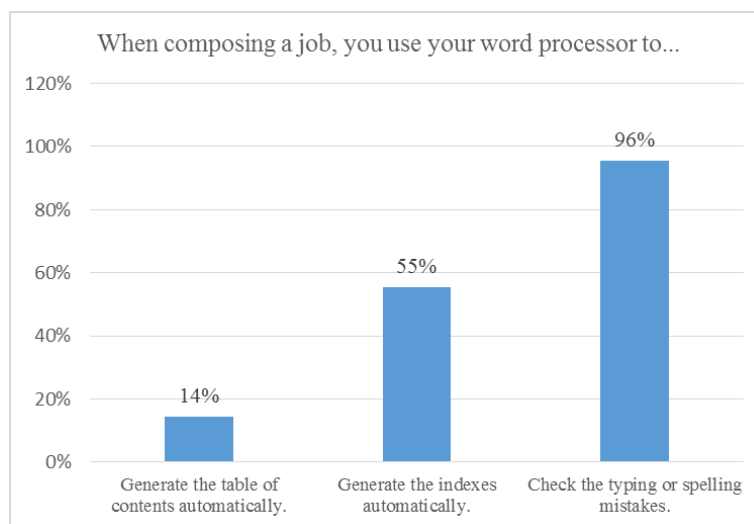

Figure 24 : Tools used for composing a job

In general, the presentation of projects has improved the structure, the wording and the citation of references of consulted documents. The evaluation of teachers is also very positive, because it has revealed another way to motivate students, which encourages their participation in a constructivist learning environment.

Students have repeatedly come to the Library or have contacted the library staff trying to answer questions, mainly regarding the structure of the work and the use of copyrighted images.

Outside the specific field of the subject, the teaching materials produced (graphics, presentations on Slideshare) have been well received in the professional academic environment related. Its distribution in social networks (Twitter, Facebook, etc.) has facilitated an inquiry beyond the one in the subject and the university environment.

3   Discussion / Conclusions

In this paper we have shown how an active learning framework has been applied to the teaching of the project subject at the graduate level. The active learning educational approach, the informational skills and 2.0 resources provided the students with an excellent opportunity to experience the interaction between theory and practice.

The overall course assessment demonstrates the value and effectiveness of the active learning model as a means of improving students' personal, collaborative and informational and communications skills. Results have not been as positive as expected.

Lack of time to register, use and discuss the utilization of resources 2.0, since the Library already has experience in scheduling training sessions on the use of some of them (ex. Prezi, using processors text, Science 2.0, how to prepare a presentation, etc.), has brought the decision to organize this kind of meetings

outside university schedule during the course 2015-2016. The professors of the "Project" courses will suggest attending such meetings.

Adoption of Web 2.0 tools in the implementation phase of the project has become increasingly important for students. It facilitates the development and acquisition of skills that go beyond the use of digital tools. Some are specific to the subjects of projects, such as the ability to manage and organize projects, and others are generic, such as teamwork or effective communication. From the professor's view, it requires a favourable attitude towards the use of technology, a digital skill that favours their application to the teaching and learning skills. To promote this attitude it is planned to organize workshops for professors in order to familiarize them with the use of Web 2.0 tools and so gradually integrate them in their day to day academic activity.

Some attitude change is required in assuming that knowledge must be shared and that its production includes many stakeholders. This change occurs slowly in a field that is quickly moving. Despite the emergence of excellent Web 2.0 tools, a general lack of knowledge has been observed. The described actions are trying to change this reality.

All actors in the initiative are considering this experience as a very positive one, thus significantly improving the learning and skills development, achieving greater student motivation and higher quality in practical projects. Therefore, the will of our team is to continue the cooperation and gradually strengthen it by using the "Project 2.0" tools at the stage of developing a project.

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