enginy@eps: Motivating the Engineering Courses

Social Valuation as a Motivating Factor

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Abstract—**This paper presents an academic initiative to increase the motivation of students for engineering topics, and discusses the results obtained. The initiative is a journal where students may publish, both in paper and in electronic format, the final reports of their laboratory works or research activities. The name of the journal is enginy@eps. The existence of this journal becomes an external element for motivating the students, since their documents are going to be reviewed by an editorial staff and are going to be published out of the classroom. The collected data shows that social recognition is still a useful element to motivate the students in technical courses.**

Keywords- student motivation; educational innovation; formal writing profile

INTRODUCTION

In the last subjects of engineer courses, students participate in autonomous works, research activities and laboratory sessions where it is necessary to go further than just to apply previously learned concepts. This kind of activities requires a lot of time and hard work not only from the students but, also from the teacher. Finally, once the work is evaluated for the course, it is usually forgotten and often the work conclusions are not used anymore. So, it seems contrary to the student's and to the teacher's motivation to foresee that their efforts will not be useful to anyone else, and that their work will be forgotten when the course ends. That situation is not a good motivating factor for the student and, of course, for the teacher.

The student motivation is a complex topic, and it is difficult to quantify [1]. In some cases, the same thing does not motivate all students at the same time. Two factors that impact on student motivation are: the social valuation and the perception of the expectation of success [1]. It is important to note that both factors are part of a multiplication equation, so if anyone of these factors is zero, the result is zero too. This means that, the student must find some positive attraction toward the educational activity, but in addition, it is necessary a positive perception regarding the accomplishment of the learning activity. There are a lot of learning environments proposed to increase the students' motivation, as an example in [2] and [5-6] a game based learning environment is used to increase the motivation of students in different courses.

Furthermore, the students in first courses, in general, have initiated the Engineering careers without a clear idea about the topics and issues related with those courses. They may have no idea about the concepts and methodologies involved in their engineer courses. And they have difficulties to explain the reasons why they have selected these particular courses instead of some others. This initial confuse situation may be a disinclining factor; and it is difficult to know how many students leave the recently initiated studies by that reason. In [7] the authors propose to design initial courses with extensive active learning components in cooperative students teams as an effort to retain those confused students. The same situation may be identified when pre-university students have to select their university studies.

Some different solutions have been proposed in our University to help students to solve this confuse situation as soon as possible: pre-university labs, adaptation courses, classrooms open door day, or talks about the features of different courses. All these solutions have a point in common: the university presents the information about their courses mainly from an institutional point of view. These solutions fail to provide more information about the real activities developed in the classrooms or information directly obtained from others students.

From another point of view, but related to the proposed work, it is necessary to take into account that, all engineering activities and results have to be explained and summarized in any technical document. So, it is not only necessary to learn good competences in technical engineering topics, but it is also necessary to acquire good technical writing skills. Cockrum et al. in [3], propose some ideas of how to design writing courses, to help students to acquire those necessary generic competences.

In this study, we propose to learn writing competences not in a separate subject, but in several subjects at the same time and in combination with each specific subject contents.

Laboratory and autonomous works typically finish with the presentation of a document, which is, in fact, a technical document. In that case, the student, with some minimum requirements proposed by the teacher, writes the document using a free format. The second goal of this work is the coordination of several subjects to propose the same template format for all kind of educational activities. So, not additional documentation must be elaborated by students, it is only necessary to adopt a common document template and some

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common writing requirements, like researchers when they want to publish a paper.

Seven different subjects have been selected to participate in this work. They have all revealed positive enhancement in both goals: the motivation of first years' students, pre-university students and authors students; and increasing the writing skills of engineering courses.

INITIAL SITUATION

Any technical course is organized in several independent subjects distributed in time. The student is motivated to learn isolated concepts in each subject and it is usually expected that the student will be able to mix those concepts and construct his/her own knowledge. Another important characteristic is related to how the concepts are learned. In traditional education methodology, it is usual to transmit the concepts from teacher to student using oral sessions. The model is changing and the main idea is that the teacher does not control the knowledge, because it is freely accessed through new technologies like internet. Nowadays, the student is in the learning centre and the teacher helps the students to construct their own point of view about the concepts.

These changes in the teaching methodology lead to more individual and in group homework, and cooperative learning activities. Those activities require a lot of time from students and from teachers in tutoring processes. In general, this kind of activities concludes by writing a technical document, which is a valuable element for the evaluation process. Those works and documents are only used for evaluation purposes and, at the end; they are stored in a box or bookcase and forgotten. In that situation, only the students and the teacher know the content of the work, since information is not shared outside of the classroom.

From the motivation's viewpoint, this behavior is not a positive factor: because both the students and the teachers keep in mind that the unique purpose of the work is to evaluate the learning process. But, what if there was a possibility of public diffusion of the work? This new feature may increase the students' motivation to do their best.

Usually, in actual fractioned knowledge courses (divided in isolated subjects), another teachers and students do not know what kinds of activities are developed in each subject, because those activities are made in the classroom with the closed doors. So, students have not a previously clear idea about the subject which is applying for. Nevertheless, that situation may be worst at the starting point of the studies. In that case, they not have sufficient resources, examples or other students' comments to discover what kind of learning activities are carried out in the university subjects.

Another aspect that has to be pointed out in this section concerns the first degree project. In technical programmes, the students must develop an independent work, in which the student should plan, carry out and report a research work. In general, the degree project concludes with a written report of the work and an oral presentation to a group of three likewise selected teachers. The same way as learning activity reports, the degree project reports are collected in the university library and forgotten there. Although, much time has been spent on those reports, they finally (and unfortunately) end up in some university bookcase. Obviously, no all project reports are suitable for public diffusion, but with a good selection, why not award the best reports with a "better life"? Maybe the expectation of a public recognition of the degree project could be a good factor of motivation to do the best.

Writing good reports may be one of the less developed skills in technical courses. Obviously, any student writes a lot of reports, but each teacher uses its own requirements adjusted to the evaluation process, so no common organization or features are shared. In fact, students just adopt the new template without any additional comprehension. No time is spent in learning how to write better reports, how to decide which information is useful and which is not, or in any other considerations about technical writing style. In research environments, reports are continuously used to explain the results of projects, and documents must follow some style if those reports have to be included in a journal. That is the same idea, but applied to student reports.

OBJECTIVES, PLANNING CHANGES AND METHODOLOGY

The proposed learning activity, for increasing the motivation and the coordination between subjects in university programs, is the publication of an annual journal called "enginy@eps". The journal opens one alternative to make classroom and project reports public.

Proposed Objectives

The publication of an annual journal was proposed with the following main goals:

- To introduce a motivation element for the students. A selection of students' works will be published in "enginy@eps". So, those students are motivated to do their best and to expose their works to readers. Furthermore, the readers (students and teachers) will be motivated to participate in the next issue and could help to create an adequate atmosphere between new and last year students.
- To introduce a motivation element for teachers. Without any public exposition of what is done in each course, it is difficult for teachers to make profit of learning activities of previous courses. So, by showing the learning activities that students develop inside the classrooms and during their degree projects, it may be possible to improve the next courses contents. On the other hand, as the students' works are not public, there is not any motivation to change the learning activities. But, when the learning activities results are published, those may be used as technical documents for future learning activities.
- To improve the technical documentation writing skills during the learning process as a multi-course learning objective. The students' papers review process may help to learn better writing and document organization skills. Although a lot of technical documents are generated by students in several courses, the student writing skills are not included as a goal of any technical course.

Courses Planning changes

The initial planning of the subjects involved in this study has been modified in order to incorporate the new learning activity. One of the most important changes is related to the activity perception by students. The proposed changes should be introduced without high increment in the student's work. So, several different options have been used to incorporate the needed changes:

- Without making major changes to the subjects to include this project. In that case, there is an activity which may be adapted easily. An example is when all students have to write a project's documentation or have to perform an experimental project, in groups of a few students. The project is related with the subject topics and each group has to deliver a report with the obtained results. In order to adapt those kinds of activities to the context of the presented study, the students have to write the project report according to the specific format defined by the enginy@eps publication.
- Adapting an existing activity but including, at the beginning of the course, some guidelines, in the form of a paper template. The different sections of the technical document (introduction, objectives, design, implementation, evaluation, conclusions) are briefly described so the students get a better idea of what they should include in each section. They are encouraged to write the Introduction and the Objectives in a simple language, as for a non-expert reader, and then to change to a more technical language for the rest of the paper.
- A new learning activity is included in the course. For instance, developing an information research work. After having introduced the students in the basic general knowledge of the subject, different topics on actual and emerging topics are proposed to them. These topics are distributed among groups of two or three students that have to elaborate on them. As a result of their research, each working group have to write a four pages article, following the journal format, which has to be presented to the rest of students of the course through a short presentation with slides in the classroom. The objective is to evaluate the autonomy of the students to seek information on existing technologies and their ability to transfer their knowledge, as well as to asses the satisfaction that it entails.
- Some previously planned activity is substituted by a new one. Before, the students had to write a homework report, but now, it has been substituted by an oral presentation together with the proposed paper format.

The changes previously described do not only impact on the activity planning, in some cases, they require new elements for the evaluation process. The new methodologies in evaluation techniques have to be adapted because the activity changes do not only modify how students report the activity conclusions, but they also modify how the subject topics are learned by students.

TABLE 1. INITIAL QUESTIONNAIRE

	Question
Q1	I like this subject
Q2	The subject topics are related to my personal expectancies
Q3	Sharing the project results is important for me.
Q4	My effort is enough to accomplish the goals of subject
Q5	I am concerned about others students having better results than me
Q6	I have confidence I will understand the concepts of this subject
Q7	I am motivated to view my work on a public journal
Q8	I am able to write a good paper
Q9	Writing is a hard word
Q10	Value from 0 (not interesting) to 10 (very interesting) the grade of motivation about viewing your name in a public journal.

TABLE 2. FINAL QUESTIONNAIRE

	Question
Q1	Writing the journal paper has increase the motivation for the subject
Q2	The motivation in the university degree has been increased with this activity.
Q3	It is important to write the results of my projects
Q4	This activity has contributed to accomplish the subject goals
Q5	I am not concerned about comparing the project results with others students
Q6	Finish the paper has been important for me
Q7	Writing is a hard word
Q8	Value from 0 (low) to 10 (high) your capacity to accomplish the activity.
Q9	Value from 0 (not interesting) to 10 (very interesting) the learning process developed during the writing activity.
Q10	Value from 0 (not interesting) to 10 (very interesting) the grade of motivation about viewing your name in a public journal.

Additionally, all subject teachers involved in the study have designed two questionnaires to quantify the impact on motivation for writing and publishing activity. The first questionnaire, see Table 1, collects the initial motivation of students when the activity is proposed. In fact, in some cases, the activity is not different from previous years, and only the technical summary format and the idea of possible election for publication are introduced. Each professor, according to the subject planning, has introduced the required changes. Table 1 shows all questions answered by the students when the activity starts. All questions can be answered within the range from 1 point (disagree) to 5 points (completely agree).

The second questionnaire has been filled by the students at the end of other activity, previously to the selection of the best papers for publication. Some questions remain unchanged intentionally and other try to measure how the student has perceived the activity.

Review Methodology and accepted papers

The review process has been organized by the corresponding teacher within each subject, but following some common review criteria. The objective of this process is to select the best and the second best papers which should be proposed to the editorial staff for the final review/accept process.

The review process for each subject has been developed in different ways, depending on the teacher's methodology. Some alternatives are:

- First, all the students had to deliver a first version of the project. After reviewing all the papers, the three best works were selected and the teacher suggested some changes to the authors. Finally, the selected students delivered the final version (camera ready version) and a second review was done to choose the paper that was proposed to the editorial staff.
- After reviewing all the documents, the teacher talked individually to each student, showed them the main errors both in the technical part and in the paper itself, and gave them some advices. Only the best papers' authors were requested to improve the document following the suggestions given to finally propose their paper to editorial staff.
- The different reports presented by all authors were available to all students and the evaluation was performed following a peer-review process where the different groups evaluate the other ones with the help of a template in order to ensure a homogeneous evaluation. The final grade of each project was calculated from the average value obtained from each group. Finally, the best evaluated project was proposed to editorial staff.

In summary, the strength of this academic activity is that it does not change significantly the methodology from the teacher perspective, but it does change a lot the perception of the students about their work and the relevance of having good writing skills. They learn that they should not focus only on the concepts or physical implementation, but they should also focus on communicating the results.

All teachers involved in the study were part of the editorial staff, so finally, all documents proposed were reviewed and accepted by all of them. In order to help the internal organization of the editorial staff, the technical courses were grouped into five different categories: building engineering, computer engineering, electronic and automatic engineering, telecommunication engineering and mathematics. One member of each area was elected as an area chairman with the following functions:

- To promote as much as possible the participation of the subjects associated to the category.
- To manage and coordinate the review process of the papers in the area.
- To maintain the area in communication with the rest of the categories in order to share best practices.

The described staff organization has been introduced as needed and allowed the participation of even subject from any technical courses present in the Universitat Illes Balears.

THE JOURNAL "ENGINY@EPS"

The annual journal called "enginy@eps" was proposed to the university community as a local initiative to promote the activities developed in technical courses at the university. The initiative opens a new space where educational works are shared between all university community members.

At present, the publication process has been performed for two courses, so the results of this study show how this kind of activity, which aims at improving the students' motivation, evolves when the students share their educational works and can read previous published works.

First year: enginy@eps is born

The first edition of the journal published 14 educational works of 9 different subjects from electrical and telecommunications engineering. All papers included were based on laboratory activities or individual research projects following some of the previously mentioned methodology changes in the subject planning.

The first edition of "enginy@eps" included 450 copies; see the cover sheet in Figure 1. The journal was distributed between students and teachers of the Engineering faculty, and some copies were sent to pre-university schools. In fact, two weeks after the presentation day, the copies were finished. That is not a scientific result, but shows how good the new publication was received by readers.

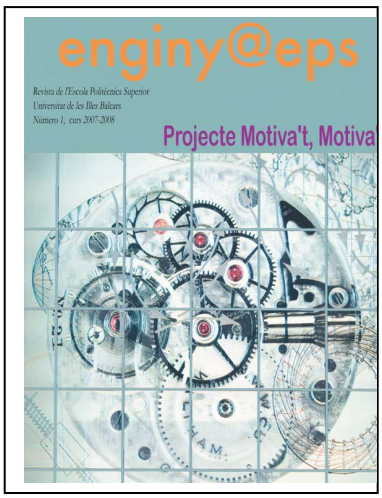


Figure 1. The "enginy@eps" cover sheet of first edition.

In that edition, some aspects employed most of the time and work of the editorial staff:

- Defining a good and easy paper-template to facilitate the writing process as well as the organization of the information for any kind of works.
- Financing the activity with external support.
- Designing the journal image, incorporating the final versions of papers and carrying it to the press.

At the end of that year and as a result of the new journal, new teachers were involved with the project. A lot of new ideas and contributions were received from the university community, promoting the inclusion of others technical courses for the next edition.

Second year: expanding the initial objectives

In the second edition, two new sections were introduced with new initial objectives:

- *Research works*: degree project reports or internal reports about new technologies were considered to be pubished in the journal. The main goals of this section are to contribute in the difussion of students projects and to motivate for reading technical information. This section starts with 6 papers from diferent degree projects, but also from teachers projects.
- *Open Section*: With the aim to contributing to create a collaboration atmosphere among students and teachers, this section publishes diferent opinions about a central topic. The central topic is selected by the editorial staff and different contributions are included: from school managers, from interview with students, from external institutions, ...

Moreover, a new impulse in the design was introduced. The journal now presents a modern aspect, with some information about internal sections on the cover sheet. See the second edition cover sheet in figure 2.

Figure 2. The "enginy@eps" cover sheet of second edition.

The second edition of "enginy@eps" included 900 copies. The journal was distributed between students and teachers of the Engineering faculty, pre-university schools and some copies where sent to other universities and external institutions.

From the point of view of management, an open journal management system [4] was adopted. The new journal management software allows the creation of an electronic edition of the journal, increasing the capabilities of difussion. By the moment, the electronic edition of the journal is used in combination with paper edition, because the journal gains more visibility and impact if it exists physically (in paper).

The impact of the journal's previous edition on students works has been noticed by teachers. When the writting activity was proposed to the students, they had a reference in their mind (last year edition). In fact, some subjects used the last year reports to improve the educational activities in their laboratory or classrooms. Last year edition has been incorporated in technical courses as an additional reference, useful for students who applied to the course, but also, usefully for other courses as an information source.

In the second year of this activity, our feeling is that the journal is a useful means to motivate the students. As soon as they had the previous issue in their hands, they expressed a lot of interest and checked it with attention. Although it may not be measured in objective terms, this is a clear indicator that social recognition is a strong motivating factor, as already stated in the literature [1].

RESULTS IN MOTIVATION

The impact of the journal in the improvement of the educational activities and on maintaining the communication between university communities may be observed in how the journal has been received and incorporated as a new tool for educational purposes. But the goal of this study is on the impact of the journal on the student's motivation.

The results in motivation are obtained from two questionnaires answered by the students at an initial stage of the writing activity and at the end of the activity, previous to the final selection of best paper for publication.

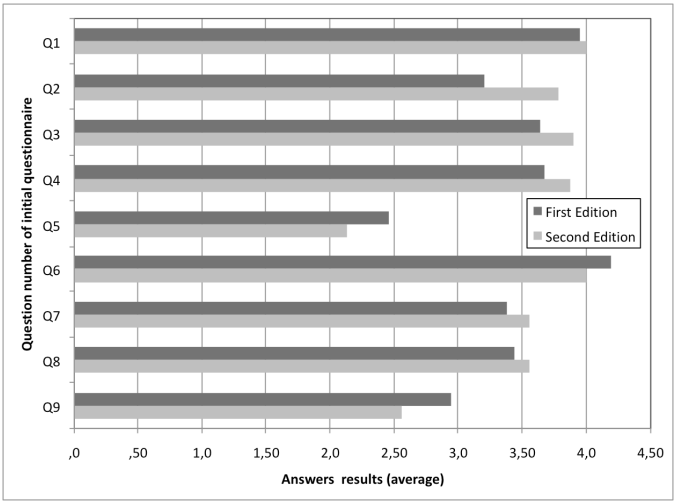


Figure 3. Initial questionnaire results evolution.

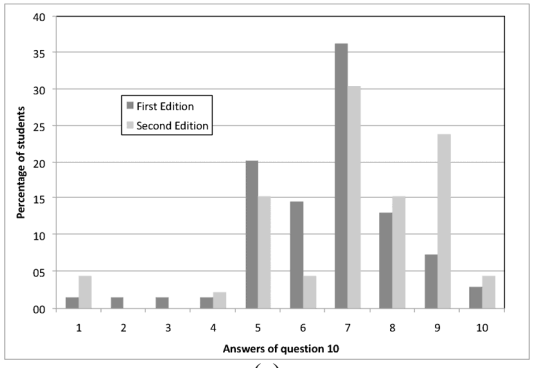
Figure 3 shows the average values initial questionnaire for both editions. It is important to remain that the students answer questions Q1 to Q9 with a maximum value of 5, while the question Q10 can be valuated until 10 and is not showed in Figure 3. Some conclusions can be obtained from the results chart:

- All students agree to consider that they like the contents of the subject and that their effort to accomplish the subject goals is enough.
- Question 3 shows how the students are increasing their interest in sharing the results of their works with other students. While the results of question 5 reveal insouciance by the comparison between students' works. These results are good for this kind of activity, because the external review of the works is a necessary step in the publishing process.
- The positive trend in the interest of students in the publication of their works is reported in the results of question 7. This may be considered an important indicator (activity valuation) of the impact on motivation. Although the values of first and second editions are similar, the number of students involved in the project was higher in the second edition than in the first one.
- Evolution of the questions 8 and 9 answers results may be considered a direct consequence of the first edition impact. While in the first edition writing a paper was considered a hard work, this process is considered less hard in the second edition, perhaps the final goal is perceived as a real fact (previous edition was published previously).
- Finally, the results of question 10, see values in table 3, may be considered a second important indicator (motivation for the activity) of the impact in motivation. The second edition impact in the results may be observed in the increment of the initial motivation.

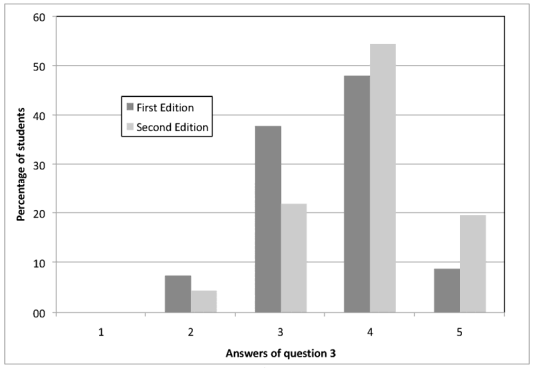
TABLE 3. INITIAL QUESTIONNAIRE STATISTICS

	Average		*Standard deviation*	
Editions	***First***	***Second***	***First***	***Second***
Q1	3.9	4.0	0.7	0.7
Q2	3.2	3.8	0.9	0.9
Q3	3.6	3.9	0.8	0.8
Q4	3.7	3.9	0.7	0.8
Q5	2.5	2.1	1.0	1.1
Q6	4.2	4.0	0.7	0.8
Q7	3.4	3.6	1.0	1.2
Q8	3.4	3.6	0.8	0.7
Q9	2.9	2.6	1.0	0.9
Q10	6.9	7.3	1.7	2.1

In Table 3, it has been collected the average and standard deviation of the initial questionnaire answers. The standard deviation is an indication of dispersion in the answers. As the values of possible answers are integers, a standard deviation lower than 1 indicates that the average is a representative value, while a standard deviation greater than 1 denotes a high dispersion in the answers. Taking into account this observation, only questions Q5, Q7, Q9 and Q10 show a standard deviation greater or equal to 1. The reason of this may be explained by the histogram of answers. In all previous enumerated questions, there are students' answers in all possible answers options. It could be due to the fact that the questions may not have a clear meaning. This comment may be observed in Figure 4, where the histogram of answers values of initial questionnaire question 10 and question 3 are shown.



(a)



(b)

Figure 4. Histogram of answers values of initial questionnaire. (a) Question 10 and (b) question 3.

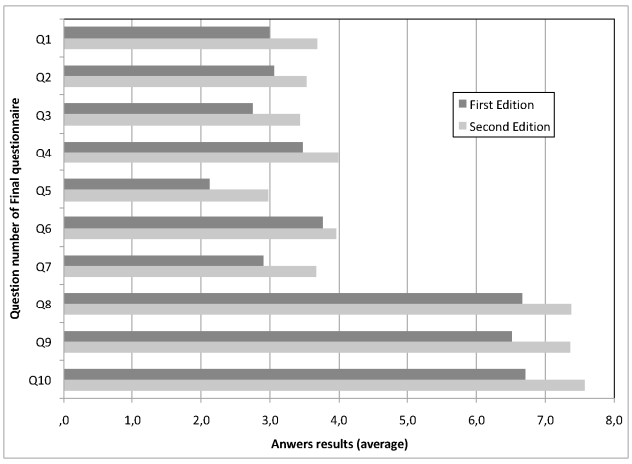


Figure 5. Final questionnaire results evolution.

On the one hand, the information observed from standard deviation may be considered in a revision of questionnaires, as an indicator of which questions must be adjusted, because it is possible that the students did not understand it. On the other hand, a standard deviation high in one question shows some discrepancies with the average answer, and could be studied with more attention.

Figure 5 shows the average values of final questionnaire for both editions. The students answer questions Q1 to Q7 with a maximum value of 5, while the questions Q8 to Q10 can be valuated until 10. From chart of Figure 5, some comments can be obtained:

- All results show a positive impact of the first edition on the second edition results, increasing the first edition results.
- The impact of writing activity has increased the student motivation from one year to the next, as shown Q1 and Q2 answer results. In fact, the importance of this activity, as perceived by student has increased too, see results of question Q3.
- A majority of students believe that this activity has helped to improve the results in the subject, see Q4.
- The importance of comparison has decreased, so the students seen to tolerate better the process of external review, or the publication of their works.
- Although the writing activity has not been considered as a hard work, finally, at the end of the process with the review, the students valuate the task developed as a hard work (question Q7).
- The students' self-esteem is increased, because they are feeling that they are capable to do similar activities again (question Q8).
- The effort of writing in a technical manner is valued positively by the students, while the motivation or expectation to see its paper published in the journal is maintained at the same level as at the beginning of the activity.

- TABLE 4. FINAL QUESTIONNAIRE STATISTICS

	Average		*Standard deviation*	
Editions	***First***	***Second***	***First***	***Second***
Q1	3.0	3.7	1.0	0.9
Q2	3.1	3.5	1.1	0.7
Q3	2.7	3.4	1.1	1.1
Q4	3.5	4.0	0.9	0.6
Q5	2.1	3.0	1.0	0.9
Q6	3.8	4.0	0.9	0.7
Q7	2.9	3.7	1.0	0.9
Q8	6.7	7.4	1.6	0.7
Q9	6.5	7.4	1.2	0.9
Q10	6.7	7.6	2.4	1.4

In Table 4, it has been collected the average and standard deviation of the final questionnaire answers. In this case, only question Q3 maintains a standard deviation high in both editions. The high number of questions with high standard deviation during the first edition could be explained taking into account that the students did not have any copy of the journal, so the activity goals were not clear to all students involved in it.

CONCLUSIONS

This study has been developed in two years and has tried to evaluate the impact on the student's motivation of public recognition using a writing activity. In technical courses there are a lot of students' activities or degree projects which may be used to create a publication. In fact, the process of publication is an educational process, where the own knowledge is compared, shared and discussed with colleges.

The proposed study has demonstrated how the process of writing, reviewing and publishing may help to improve the motivation of students in different areas: personal motivation, implication with the subject activities or as a reference for future students. The activity has been valuated positively by students in both editions, as it is observed in the final results.

The writing process may be a useful educational process, not just for the authors of the best papers, but also for all the students involved in the review process.

The impact on future degree project reports is not evaluated yet, but we believe that, in general, the writing skills will be improved, and this kind of activities allows promotion of non-classroom activities, which may impact in the same way in all courses. Perhaps, theses kind of activities are necessary to learn socio-professional capacities in future engineer courses.

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