Actions for Academic Performance Improvement of University Newcomer Students in an Electronics Introductory Subject

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ABSTRACT

The subject Electronics for Telecommunications (ET) is taught in the first semester of the Telecommunications degrees at the Castelldefels School of Telecommunications and Aerospace Engineering (EETAC). The academic performance is relatively low compared to the same course taught in a double degree of Aerospace and Telecommunications, in part justified by the large difference in the university access marks of the students between both degrees. Several actions have been implemented in courses 2019/20 and 2020/21 to address this issue, especially in theory classes where student attendance is lower than in laboratory sessions. Implementation difficulties have arisen because the presence of the COVID pandemic. Even so, performance has greatly increased, especially at the first semester of each academic year. In addition, a student survey shows a good satisfaction with the introduced actions and others in process of introduction or assessment. Some of the actions, particularly those to be applied in the theory sessions, could be easily extrapolated to other first-semester courses of the degrees.

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1 INTRODUCTION

The subject ET (Electronics for Telecommunications) belongs to the first term (1A) of the Telecommunications Bachelor degrees and the double Bachelor degree of Aerospace and Telecommunications at the EETAC (Castelldefels School of Telecommunications and Aerospace Engineering) of the UPC (Universitat Politècnica de Catalunya). Enrolment in Telecommunications degrees is 120 students (100 in September and 20 in February) and 40 students in the double degree. In the first semester of each academic year, there are separated class groups of Telecommunications and double degrees, but on the second semester, they share the same class groups.

Student pass rate of the degrees was analyzed for the three academic years before the implementation of the proposed actions (16/17, 17/18 and 18/19). During the first semester of each year, pass rate in the double degree was relatively high (approximately 70 %). However, in the Telecommunications degrees pass rate was significantly lower and declining from 41.9 % in 2016/17 course to only 19.4 % in 2018/19. In the second semester of each year, with shared class groups, most of the students are repeaters and from Telecommunications degrees, and the pass rate ranged between 46.7% and 34.4%.

These large differences in the student pass rate between both degrees are mainly justified by the respective admission marks (ranging from 5.0 to 14.0 in Catalonia). Telecommunication degrees have admission marks of 5.0 because not all places are filled. Double degree has an admission mark that has increased from 9.29 in 2016/17 to 10.38 in 2018/19. Furthermore, average access marks of double degree students are 2.5 to 3.5 points higher than Telecommunications students. Additionally, students' profile is heterogeneous in the Telecommunication degrees and more homogeneous in the double degree (students with good aptitude and attitude, in general).

The ET subject is organized in theory classes (large group, 50 students maximum) and laboratory classes (small group, 25 students maximum). Theory classes are based on lectures and resolution of exercises. Laboratory sessions consist on experimental developments based on preliminary laboratory assignments. Theory accounts for 60 % and laboratory for 40 % of the final grade.

Double degree students attend regularly to both theory and laboratory classes. On the other hand, as the course advances, student attendance to theory classes for Telecommunications groups decreases while attendance to laboratory sessions keeps more regular due to continuous assessment [1]. Theory classes include midterm and final exams. Laboratory marks are higher because students work in groups of two or three members. In this way, some students benefit working with mates who have better performance, thus improving motivation and marks than working alone. Lecturer continuous feedback in laboratory classes can also make a difference and become another positive factor [2].

Our aim is to increase the student pass rate of the ET subject, in particular for the Telecommunications degrees and by increasing the theory exams marks. We believe

that a greater pass rate will be possible increasing students' engagement, motivation and implication. Therefore, several actions are proposed and some of them already implemented to achieve this goal.

2 PROPOSED ACTIONS: DESCRIPTION AND DEVELOPMENT

We propose 7 actions, 3 have already been implemented, mainly focusing on theory classes, and 4 are going to be implemented in the next academic course, mainly focusing on lab classes. We describe these actions and their motivation, methodology and development during 4 semesters corresponding to the courses 2019-20 and 2020-21.

2.1 Action 1: Initial tutoring meeting

Most of first semester students enrolling the ET subject each academic year are university newcomers. Our School organizes welcome sessions for discussing most commons issues and an initial academic tutor is assigned to each student for guiding them through the first year of the Bachelor degree studies [3]. In addition, each lecturer has several tutorial hours (6 h for full-time personnel) at his office for solving the students doubts and questions about the subjects he teaches. This last resource, which can be very useful, is, however, not much used by new ET students, especially those in Telecommunication degrees. Students show prevention for attending tutoring time at the lecturer office, maybe because this resource is not usually present in pre-university studies.

In order to palliate this issue, we propose the ET lecturer meet all their students for a first interview within its tutorial time at his office, generally 5-10 minutes long. Students can attend alone or in groups, for example those used for the laboratory classes. The lecturer fills a form sheet with student personal information (name, age, pre-university studies and access mark) and informs the student on common academic issues: lecturer tutorial time and purpose, weekly study time, class attendance control, proposals of exercises, and bibliography. These indications are also given in the initial theory class and are intended to reinforce the message through personal interaction. Students can also put open questions they consider to the lecturer. The main goal is to first personally interact with the students to promote their use of the lecturer tutorial time from the very first week in order to improve their academic success. In addition, there are some questions addressed specifically to repeater students to find out why they failed the subject and agree with right proposals for succeeding in the new course.

This action was carried out the first two semesters and also the fourth. In the third semester, partly due to COVID pandemic, it was replaced by a midterm tutoring for those who failed the midterm exam.

2.2 Action 2: Attendance control at theory classes

At laboratory classes, attendance is monitored indirectly because students are assessed at each session. However, assessment of theory content is carried out by means of 2 exams, one at midterm (accounting for 25 % of the overall assessment of

ET) and another at the end of the semester (accounting for 35 %). By default, attendance is not monitored at theory classes. Unfortunately, and for many subjects, student attendance decreases while the course advances, especially in Telecommunications degrees. This has a strong impact in their possibilities of passing the course.

Therefore, we propose implementing an attendance control at theory classes. While it may seem like an out-of-place measure at the university level, it is considered to be beneficial for newcomer students. In this way, missing students can be contacted by the lecturers (by e-mail or in laboratory classes, if they attend) to find out the reason for non-attendance and try to redress the situation, if necessary, by mutual agreement.

In the first semester, time for problem discussion (Action 3) was used for attendance control. In the second semester, however, it was stopped after classes became remote due to COVID. In the third semester, even though theory classes became remote some weeks later, attendance was yet monitored thanks to Google Meet (the used remote platform) that sends attendance automated reports. In the fourth semester, again in face-to-face mode, attendance was surveilled and annotated trough an attendance tool available in Atenea, the virtual platform used in the UPC. Students who were repeatedly not attending theory classes were contacted, mostly by e-mail, and some of them returned to classes.

2.3 Weekly exercises proposal

In order to encourage students to attend theory classes, a weekly list of exercises is proposed as homework. At the beginning of each class, students discuss problem solutions with each other and then the lecturer and the students solve the problems on the board. Students who do not do the exercises regularly are contacted to be able to correct this situation.

This action was implemented in all semesters, including those in which classes were remote. In the first semester we annotated who did them while discussing the exercises in groups. In the second semester, however, this control was not performed when switching classes to remote format. In the third semester, despite most classes were remote, the control was activated again creating tasks in Atenea where students scanned their solutions and submit them before the session. In the fourth semester the control was implemented in the same way.

2.4 Action 4: Demonstrator of the final laboratory project

In the last two laboratory sessions, students implement a short project that covers many of the course topics. The project focuses on measuring and controlling the temperature of a small-scale room. Students have to implement it in a breadboard. This action proposes to implement a prototype in printed circuit board (PCB) in order to show it to the students as a demonstrator. Fig. 1 shows the prototype and its schematic implemented with the Proteus software (Labcenter), which also allows its electronic simulation. The demonstrator will be shown at the beginning of the ET course to increase the motivation and interest of the students towards the subject and also before they start the lab project. In addition, PCBs without the components

(students buy the components at the beginning of the course) will be freely distributed to students that want to solder and test the project in the PCB. The demonstrator has been just finished and will be used in the following courses.

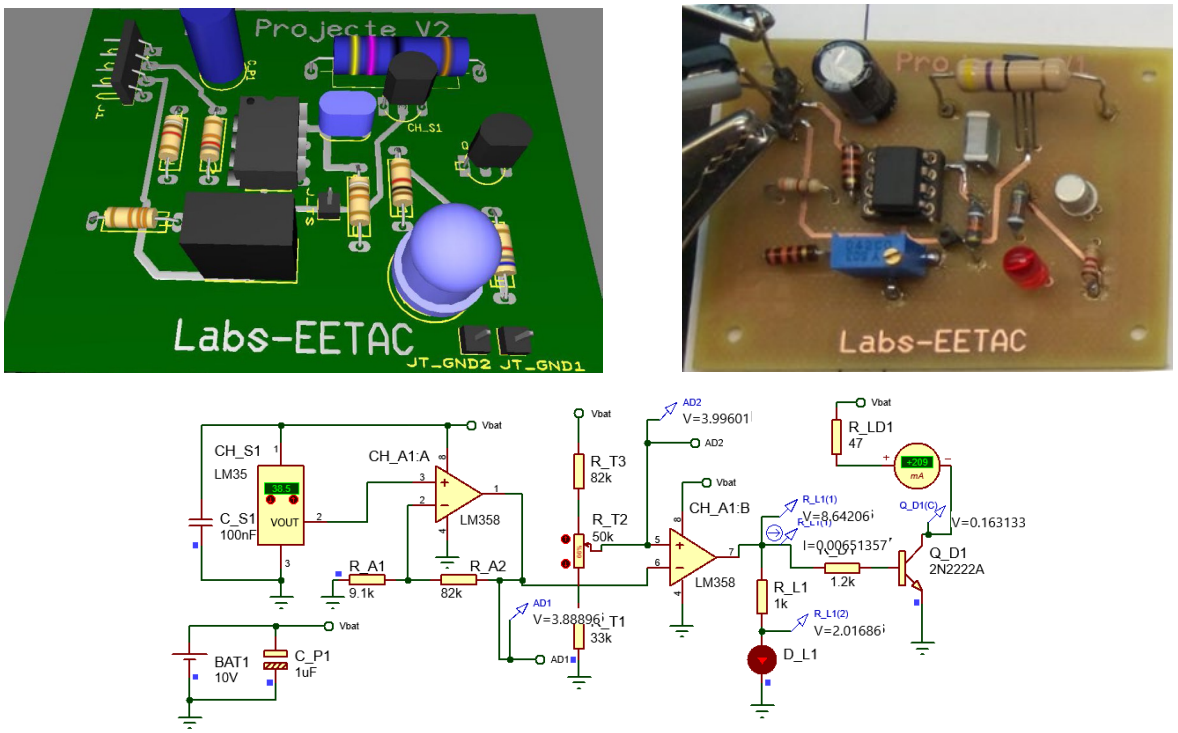

Fig. 1. Laboratory project prototype and its simulation with the software Proteus (Labcenter).

2.5 Action 5: Additional module for the final laboratory project

Fig. 2 shows a digital thermometer based on Arduino that will be used to monitor current and reference temperatures when connected to the prototype of the final project. The module will be used by student lab groups to give more visibility to the work done. This module will also be used as an application example for CSD (Digital Circuits and Systems), a second-year subject, thus promoting interaction between subjects. As the demonstrator of action 5, the module has just been finished and will also be used in the following courses.

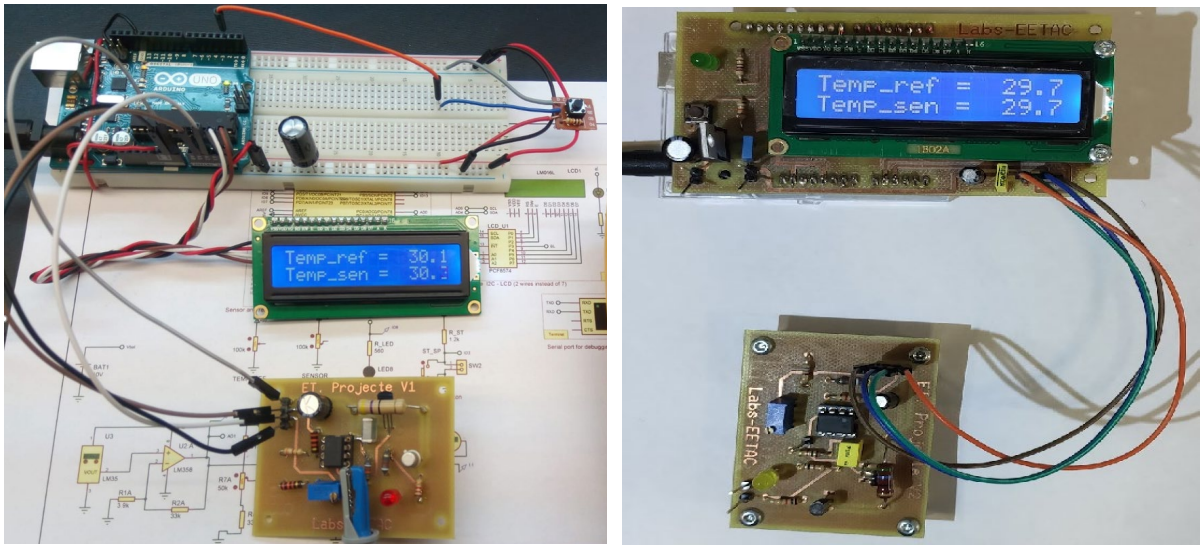

Fig. 2. Displaying current and reference temperatures with the additional module .

2.6 Action 6: Portable multi-instrument device

We have acquired 12 portable multi-instrument devices to be used by the students outside the laboratory (Fig. 3) [4]. The device can be connected to a laptop via USB. Its use can allow students to better prepare the experiments, especially to those student groups who present major difficulties in following the lab classes at a good pace. It would also allow to organize remote labs (at least in part) if laboratories were closed for unforeseen reasons, as was the case during COVID pandemic. In this case, more devices should be purchased to reach all students or establish a loan system. The devices will be distributed to the students in the following courses.

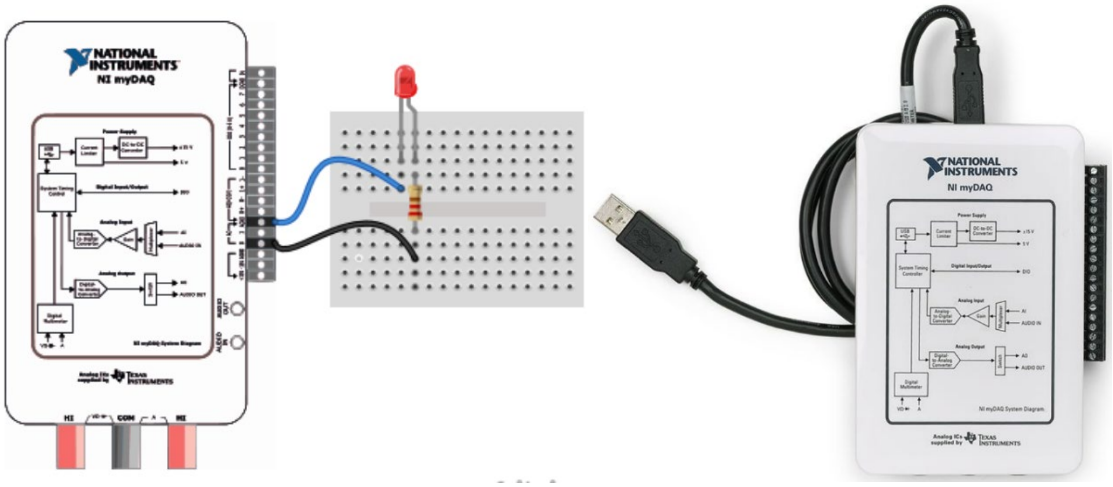

Fig. 3. NI myDAQ, portable multifunctional instrument from National Instruments.

2.7 Action 7: Initial preparatory course

Before starting September classes, the School offers optional preparatory courses of 15 hours in basic subjects (Physics, Mathematics, and Graphic Expression) [5], aimed especially at students from secondary and vocational school who are lacking comprehension on these basic topics and need to review some of these concepts in

order to have a better starting of the studies at the EETAC. Even though no electronics previous knowledge is required for ET, we have proposed the same kind of introductory course. Its first edition will be in September 2022.

The intention is to address it especially to students with low university access marks, with no or little prior knowledge of the subject and/or with little or no experience with the basic laboratory instrumentation. The ET preparatory course will consist of some introductory theoretical and laboratory lessons. It is expected registered students have a better initial adaptation to the ET subject and hopefully increase the pass rate.

3 STUDENT SURVEY AND FINAL ASSESSMENT

3.1 Student survey

At the end of the 4th semester, 45 students filled in a survey to assess the proposed actions. Table 1 shows the results, showing for each action the number of students that find it useful or not useful. Some of the students did not know or answer.

Table 1. Results of the survey about the actions to 45 students

Action	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Useful	30	36	43	36	34	36	35
Not useful	7	7	2	4	3	4	4
Don't know/answer	8	2	0	5	8	5	6

Based on the results of the surveys, it is considered positive to continue with actions 1 to 3. Actions 4 to 7 are also considered useful and will be initiated in the following course starting at September 2022.

3.2 Student performance

The project has been developed in a complicated context due to the COVID pandemic. Table 2 shows the student pass rate during the first semester (S1) of each academic year. Included are the 2 semesters where the improvement actions have been implemented as well as the immediately preceding one (*2018/19*, in *italic*). If we compare the latter with the 2019/20 academic year, the overall pass rate rose significantly, from 35,1 % to 53,8 %. In the case of Telecommunication degrees, the pass rate doubled and also rose significantly in the double degree. In the 2020/21 year, there was a slight drop, which we attribute in part to the situation caused by COVID. Anyhow, the pass rate is higher than it was before this project began.

Table 3 shows the pass rate of students during the second semester (S2), where there are not differentiated groups between degrees. As can be seen, the number of students fell in the 2019/20 semester due to the increase in pass rate during the first semester, which is a positive fact. In addition, pass rate also rose significantly with respect to the 2018/19 year. In the 2020/21 year, the pass rate was again relatively low and equal to that of the 2018/19 year.

Table 2. Student pass rate of ET during the first semester. In italic the academic year (18/19) before the improvement actions were applied.

	Total			Telecom Degree			Double Degree		
Course	**Stud**	**Pass**	**%**	**Stud**	**Pass**	**%**	**Stud**	**Pass**	**%**
18/19-S1	*151*	*53*	*35.1*	*103*	*20*	*19.4*	*48*	*33*	*68.8*
19/20-S1	160	86	53.8	117	49	41.9	43	37	86.0
20/21-S1	149	70	47.0	109	37	33.9	40	33	82.5

Table 2. Student pass rate of ET during the second semester. In italic the academic year before the improvement actions were applied.

	Total		
***Course**	**Stud**	**Pass**	**%**
18/19-S2	*79*	*30*	*38.0*
19/20-S2	55	29	52.7
20/21-S2	71	27	38.0

4 CONCLUSIONS

Several actions have been implemented and other are in progress in order to improve the academic performance of university newcomer students in an electronics introductory course. The actions are both addressed to theory and laboratory classes. The actions were well rated by students in a survey and the academic performance of both Telecommunications and double-degree students increased.

5 ACKNOWLEDGMENTS

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