Application of Cooperative Learning Techniques in Teaching a Programming Language

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***Abstract*—This article describes the methodology followed in Computer Sciences and Microprocessor courses during the last academic year. All the performed activities was based on cooperative task that students developed in groups. That groups were made up by the professor after a diagnostic test. Through implementation of this methodology, the students showed a high degree of satisfaction and consequently, the results of the evaluations has been very successful. The number of passing students were rather better than the previous academic years. Furthermore, the desertion ratio decreased quite a lot.**

Keywords: teaching methodology, diagnostic test, cooperative activities.

I. INTRODUCTION

The European Higher Education Space represents a challenge for whole European University [1]. Under this new scenario, the change in teaching methodologies is different with respect to was developed during the past years. While learning is one of the basic key of this new system, as it was in the former, this new approach in learning tends to be flexible using methodologies that help students discover new concepts by their self and enhance their transverse skills.

Although there are many proposal about methodology [2], it should not be forgotten to reward horizon of knowledge and the effort made by the student to achieve the objectives. On the other hand, one of the new tasks facing the teacher is to determine which methodology is appropriate to transfer knowledge and whether it is possible to adapt them to the particular needs of the course, group, school, etc. That is, the "methodology of the book" should be put into practice by the professor with responsibility.

There is nothing new that under this different horizon of education, the professor and student roles have changed. The professor is primarily a guide, a driver for the students to actively construct their own knowledge. The movement towards these new roles is dynamic and the professor must transfer the autonomy leaning gradually and providing guidelines to students.

On the other hand, it must be aware that there are courses inside the academic program which allows this transfer more fluidly; that is the changes in the roles pass almost unnoticed by the students. Among these courses are those that have a high practical component and naturally require an active, hard and continuous participation of students.

In this article the methodology followed in teaching in Computer Science course of the Degree of Industrial Electronics and Automation is presented. Computer Science is a course called "fundamental" and it is common to all dregrees. However this pilot experience was carried out with a group of students of Degree in Electronics. Given the good results achieved under this teaching method was implemented in the Microprocessor course that belong to the old program (Technical Engineering). This course also has a high component of programming (Assembler program) and the main objective was to improve tracking results and reduce the dropout rate for the same the course.

The proposed methodology is based on cooperative learning tasks that professors proposed to students. The students were organized by groups and they can address the acquisition of new knowledge, implement and evaluate themselves as compared to their partners.

This article is organized as follows. Section 2 presents the context of cooperative application and the reasons that have led to its application under the European Higher Education Space. Section 3 describes some of the activities performed during the course. Section 4 shows the results of the June examinations of the 2010/2011 academic year. Finally, conclusions and future works are developed in Section 5.

II. BACKGROUND OF THE METHODOLOGY

Computer Science is one of the courses considered as fundamentals in the new academic programs; therefore it is a common course for all ungraduated studies (Mechanical, Chemistry, Electric and Electronics and Automation) at Escuela Universitaria de Ingeniería Técnica Industrial of the Universidad Politécnica de Madrid.

Noteworthy that in the older academic program (Diploma in any discipline) Computer Science was taught like a course called *Foundations of Computer Science*. The content of both courses focuses on the *C* programming language, but in the new course an introduction of MatLab programming is also taught.

The course of Computer Science has 6 ECTS (European Credit Transfer and Accumulation System) and have 5 hours

per week. From these 5 hours, 2 are lectures, 2 hours for problem classes and 1 hour for laboratory class. The course is taught during the second semester of the first academic year.

Except for a slight variant, the group of professors who taught the older course of *Foundations of Computer Science*, is now including in the new course of Computer Science, therefore the comparisons are perfectly acceptable.

The methodological change is a consequence of the change imposed by the European Space of Higher Education, and Computing Science, is a course well suited to implement new methodologies due to its high practical component.

Under the hypothesis of "The best way to learn programming is programming", the border between lectures, and practical problems is diffuse, since it is the student who must learn to program with the professor's guide and a great personal effort.

As it was mentioned before, with respect to Microprocessor course it is possible to applied the same hypothesis to Computer Science course. The Microprocessor course belong to old study plans in the Technical Engineer (Industrial Electronic specialty) and it had a high component of programming but in this case in Assembly Language. Traditionally this course was rejected by the students because low-level programming is hard and complex. In this course student used Assembler language to program a typical Motorola processor and a peripheral device called VIA 6522.

Because a part of the of professors of Computer Science is also for Microprocessors, it was also decided to implement the cooperative work methodology in Microprocessor course to improve the poor academic results achieved by students.

A. Why cooperative work as methodology ?

Cooperative learning refers to an alternative way of organizing the cognitive processes for improving the teaching-learning process both inside and outside the classroom. The objective of its implementation is to overcome certain "gaps" produced with the exclusive application of traditional learning techniques, that is more interested in performance results than individual group responsibilities. The cooperative methodology needs homogeneous students teams and each team need a unique leader [3]. In the most part of the case, the leader is a student who has special abilities related with the course and, the leader emerge naturally in the group.

By contrast, through the methods of cooperative learning techniques, this is achieved according to [4] five elements: positive interdependence, face to face interaction, individual responsibility, social skills and self-processing group.

While cooperative learning techniques have many advantages [5] such as direct learning concepts, improving school motivation, development of greater independence and autonomy, etc., there are also some elements that can turn difficult their implementation like;

- Classrooms unsuitable for the development of the cooperative methodology,
- Difficult in discerning about what might be done in cooperative activities and what cannot be done with such techniques,
- Increase the number of hours that the teacher must spend to prepare, edit and evaluate the tasks,
- Lack of experience of professors,
- High number of students per group.

Taking into account the previous discussion, before considering this technique as a potential teaching methodology, professors must think about the possibilities for success with this technique and what are the real possibilities to applied them in the course.

Note that the entire group of professors of Computer Science and Microprocessor previously received one course about this methodology of teaching. Furthermore, it is worth mentioning that there are three classrooms adapted for performing cooperative work at the School. These are especially airy classrooms with capacity of relocation of tables and chairs.

III. METHODOLOGY DESCRIPTION

A. Organization of working groups

1) Computer Science Course

The teaching of the course is shared with other School Department and the Department of Electronics, control and Computer Science offers classes to the specializations of Chemistry, Electricity and Electronics. The computer course is, therefore, divided in 6 groups. Each one is consisted of approximately 55 students, by group. This new experience has been made with an electronics degree group that has 53 students.

A diagnostic test is carried out the first day of class, to assess the overall students' computer skills in order to obtain conclusions about the degree of predisposition that the student has with respect to the course. The diagnostic evaluation is not intended to assess prior knowledge that students have about the syllabus being taught in the course.

The diagnostic test to students included the following questions:

1. What was your study center before? (Indicate Name of Institute, College, School).
2. Do you have computer at home? Describe the characteristics of your computer.
3. What is the difference between RAM and ROM?
4. What OS has your computer?
5. How many hours you are using the computer and for what reasons?
6. How can the computer calculate the perimeter of a square of side L 1000 times. Indicate this graphically.

With question 1, it is intended to know the place of student's previous study. Students who come from schools / colleges where students are taught computer science or from

other engineering schools or repeaters are considered potential group leaders.

Questions 2, 3 and 4 are intended to investigate computer basics. Of the 53 students in the group only one student does not have a computer. Among other students who have computer, only 10% could adequately describe the characteristics of their computer.

Students spend an average of three hours daily being the social networks their main attraction. 40% of the students said that they are using the computer as a study and information search tool .

The last question was answered by 20% of students who were also students with some connection with computer courses.

During the evaluation of the diagnostic test, students are separated into 12 working groups in each of them at least one student had already answered question 6 and the other two remaining students were chosen from among those with questions 2, 3 and 4 correctly answered.

The remaining group members were chosen considering data such as sex, origin and age. Based upon this selection, a homogenous groups are formed.

For the realization of cooperative classes, teachers prepared specific material which was essentially consisted of two parts; a first theoretical part in order to reinforce the themes explained in the lecture and a second parte dedicated to perform many exercises in students own laptops.

It should be noted that in a group of 5 students with at least 3 laptops the students increased threefold the actual hours of laboratory of the course.

a) Example of Application

In this sub-section we summarize the activities undertaken in learning loops (for, while and do-while).

Three dossiers are distributed among the students containing the following :

• Theory. A brief theoretical explanation of how the loop in question including a flowchart.

• Examples. Two simple examples of how to use the loop, including the solution in each iteration.

• An exercise proposed to be solved by the group.

• Twenty proposed exercises to be solved by each group.

The activity takes place during the two-hour class. Each group studies the three loops in C and each group member becomes "expert" of "their" loop. After half an hour each expert explains to the other members the theory of "their" loop and worked examples.

In half hour the group must perform and compile the three tasks proposed to the group.

In the final half hour a group representative resolves one of the individual exercises on the Board.

The next two classes the group should approach the solution of twenty exercises proposed to be delivered to the teacher electronically.

Assessment is the next class in which a group member chosen by lot must display a exercise also chosen by lot. Note that the student gets is the same as it gets to his bandmates.

2) Microprocessor Course

In the course of microprocessors will have only two groups; 45 students at the morning group and 65 students the afternoon group. This course belongs to the old degree and has 4.5 credits. That is, two hours of theory and problems per week and two laboratory every other week.

While the ultimate goal of educational work is to reduce the dropout rate, increase the success rate and increase student satisfaction with the course, cooperative methodology had to be adapted to what was originally planned for the course : course work (mandatory), lab (mandatory) and final exam.

Diagnostic test was performed with only two questions.

1. Have you done this course before?
2. Have you ever programmed a microcontroller or microprocessor before? If yes please indicate its type and the programming language.

The first question was aimed to evaluate the number of repeating students who attend a class and the second one was intended to assess whether there was prior knowledge in programming microprocessors.

This question allowed the separation of the students into groups of 5 or 6 students in which at least one student had prior knowledge of microprocessors.

A different work was prepared for each group. It consists of two parts:

- Part I: It consists of 4 blocks of exercises of the main topics of the syllabus of the course. The first and second block contain 5 exercises. each one deals with basic programming in assembly language and addressing modes. The third block contains 8 exercises using vectors and strings, and finally, the fourth block contains 8 exercises about advanced programming using the stack and subroutines.
- Part II: simulation work of a real problem which includes the programming of a microprocessor via switches and timers.

Each of the blocks had a deadline limit and the whole group should attend the presentation and defense of an exercise chosen a randomly by the teacher. Non-attendance of a student meant a not approved in that part.

IV. RESULTS

The educational methodology applied showed an improvement in the academic performance of the students, both the number of students who passed the subject and a great decreasing of the number of students absent. The results presented at this section only consider the first call of the exam.

Fig. 1 shows a bar chart where can be shown the performance of the A 104 group, which worked with cooperative activities and whose students are of the Degree in Industrial Electronics and Automatic Engineering. From the 57 students, 45 passed, 8 were absent, and 4 failed the subject in the first call of the exam. Furthermore, 27 students have obtained notable (7 on a scale from 1 to 10) or higher, and 2 distinctions.

Fig. 2 shows the results of the A 109 group. This group is of students of the Degree of Electronics and the results are clearly less becoming. From the 42 students only 17 passed, 9 were absent and the rest failed the subject.

Regarding to the students of the Degree in Electricity, they were organized in two groups with a total of 83 students. From the total, 42 students passed, 30 were absent and 11 failed. The Fig. 3 summarizes these results.

The students of the Degree in Chemical Engineering were organized as well in two groups with a total of 80 students. From the total, 24 students passed, 25 were absent, and 31 failed the subject. The Fig. 4 shows the results for this group.

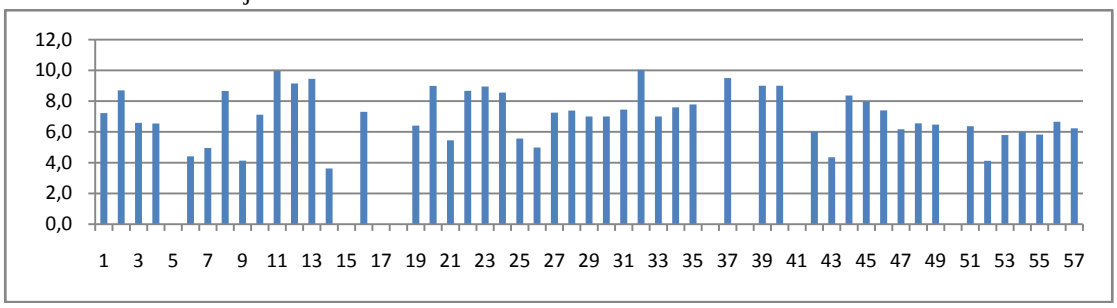

Figure 1. A104 Group. Degree in Industrial Electronics and Automatic Engineering. Methodology: Cooperative Activities.

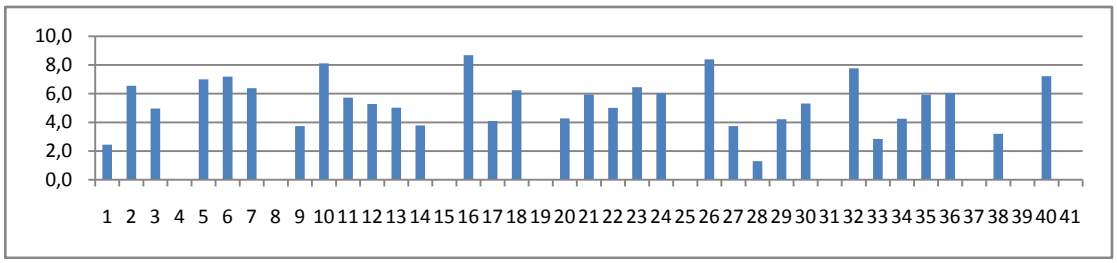

Figure 2. A109 Group. Degree in Industrial Electronics and Automatic Engineering.

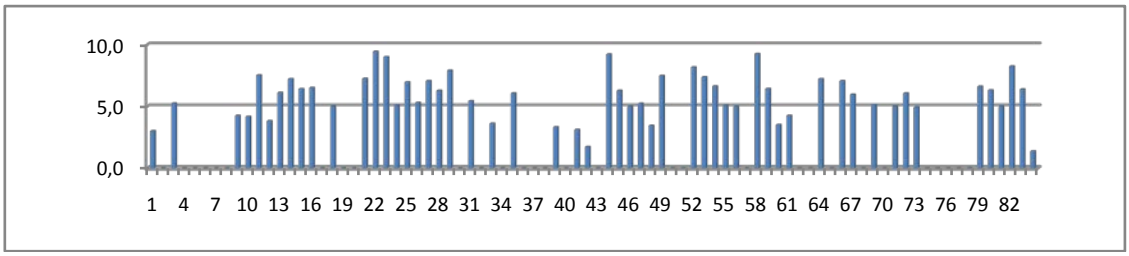

Figure 3. E100 and E105 Groups. Degree in Electricity.

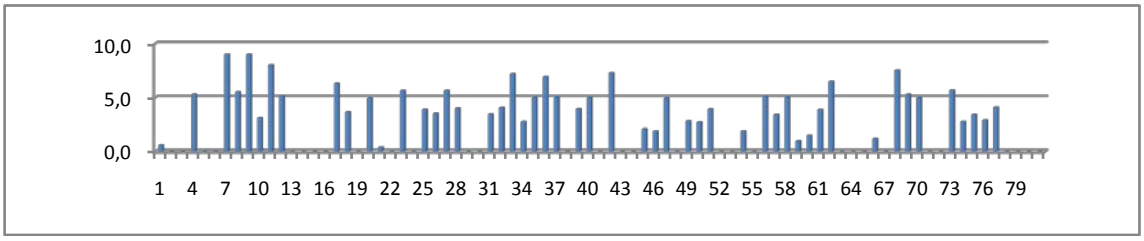

Figure 4. Q103 and Q108 Groups. Degree in Chemical Engineering.

Regarding to the Microprocessor course, the result was likewise acceptable. At the Fig. 5, the results of the call of June during the 2009/2010 academic year are shown. It can be seen a high rate of absent students and a very low rate of passed/failed students.

At the Fig. 6 are shown the results obtained during the 2010/2011 academic year at the call of June, where cooperative methodologies were implemented.

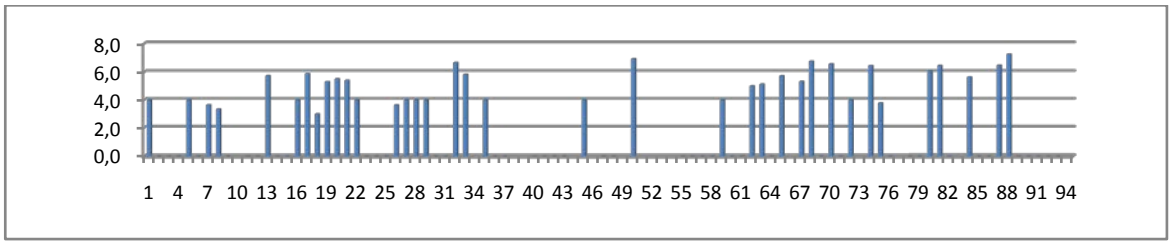

Figure 5. Microprocessor course. Technical Industrial Engineering (Industrial Electronics). Academic year 2009/2010.

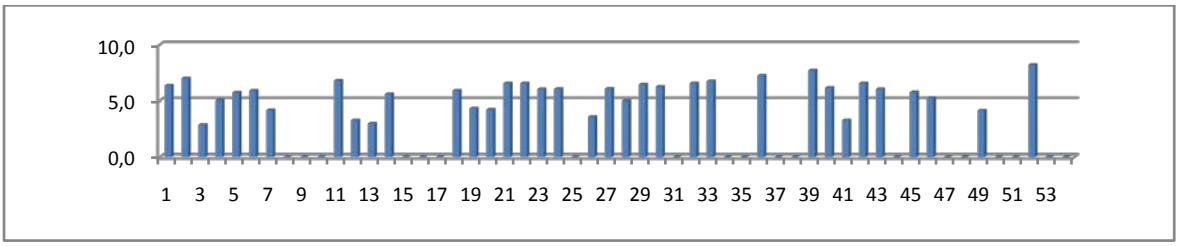

Figure 6. Microprocessor course. Technical Industrial Engineering, (Industrial Electronics). Academic year 2010/2011. Cooperative Methodology.

V. CONCLUSIONES

In this article a pedagogical methodology implemented with the students of the new Degrees under European Higher Education Space has been presented. The methodology was implemented in a fundamental course called Computer Science. On the other hand, the same methodology was also applied to Microprocessor course that is based in programming under Assembler Language. This course belong to the Technical Industrial Engineering.

The methodology was introduced in one of the groups of the Degree in Industrial Electronics and Automatic Engineering. It may be thought that these students have a natural tendency to the "Computer Scicence course, but the results of the examination session showed that the educational methodology influences considerably in the successful of the students. Not only the cooperative methodology has encouraged students to work continuously with the subject, but it has reduced the time rate to think out the concepts about the subject and improved quickly the initial level of the students, which has allowd to go into the concepts and problems in depth (the number of students with more than notable mark is higher of 50%).

The difference with the other degrees is obvious. The students of the Degree in Electricity and Chemical Engineering have a high rate of absent students, and from the majority of students who passed, they do not exceed the notable.

With regard to Microprocessor subject, it could be said that the satisfaction degree among the students has improved in comparison with the previous academic year, and the rate of passes has been increased due to the educational methodology implemented.

It can be said that the cooperative activities are very stimulant in order to facilitate the learning of the students, increasing the autonomy level of the student, and helping definitely for the continuous study of the subject.

Due to the good academic results obtained, the teachers propose themselves to spread this educational methodology next academic year to a mixed group of "Computing" composed by students of Electronics and Chemistry Degrees.

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