A web-based approach to the microwave engineering cooperative learning

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I. Abstract

For a lecture, the most challenging project consists in promoting the students learning process, enhancing their satisfaction. In engineering studies, due to the strong mathematical background required in many of the subjects, this scope is sometimes extremely hard to achieve. In this paper, an experience about this concerning is exposed; particularly, in Microwave Engineering course taught at the University of Jaén (Spain). For that purpose, the material of Microwave Engineering course has been provided to the student through a web educational based-platform. This platform is used to promote a collaborative learning process.

II. Introduction

Since the Sorbonne Joint Declaration on the harmonisation of the architecture of the European higher education system in 1998, one of the most ambitious and challenging process of unification in Europe has been to build an unified concept of the European University. Among the different steps followed in this path by the Spanish Higher Education System, the adaptation process to European Credit Transfer System is one of the main concerns for the Spanish Universities. The integration and equivalence of the Spanish studies with the rest of the European universities, is the key point of this challenging process in Spain.

This new learning concept promotes the complete implication of the students. In all the knowledge areas, concerns arise about the active participation of the students. Several approaches have been proposed in order to reach a complete integration of the students during the lectures. One of these approaches is the cooperative learning (CL), which is defined as a teaching strategy focused on small teams of student with different skill levels, using a variety of learning activities[1], [2],[3]. The improvement of this learning activities should concerned the use of new technologies, such as internet-based tools, allowing a fast and easy-to-learning access to the knowledge.

This paper describes a experience of cooperative-based learning in Microwave Engineering, within a mandatory course for all students in Telecommunication Engineering at the University of Jaén. The subject consists of 45 lecture hours and 45 laboratory and practical hours offered in the first semester of the 4th year. The content of this subject is built based on a strong mathematics and physics background, which impinges on the recognised difficulty in microwave learning, therefore, it is mandatory to found challenging activities to stimulate the full implication in the learning process. This course on Microwave Engineering incorporates an important education model known as collaborative-learning, supported by a web-based tool, which allows student to manage learning resources in an integrated system.

A web-based learning system allows students to access the learning content of outside regular school hours and at they home. This kind of system liberates learners from regimented conduct of traditional courses, which is a positive consequence, but, also decreases the possibilities of performing cooperative learning activities, which could be a drawback. In order to avoid this negative consequence, several cooperation tools are integrated in the web-based learning environment employed in the course, i.e., forums, chat, e-mail integrated, etc.

The findings about the improvement of the students academic results due to the use of this tool will be explained.

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III. Cooperative learning

In this section, the cooperative learning concept is reviewed. It may be defined as the instructional use of small groups where students work together to maximize their own and each others' learning. Carefully structured cooperative learning involves people working in teams to accomplish a common goal, under conditions that involve both *positive interdependence* (all members must cooperate to complete the task) and *individual and group accountability* (each member is accountable for the complete final outcome) [6].

This teaching approach is one of the most investigated strategies. Research about cooperative learning has demonstrated that students who have opportunities to work collaboratively, learn faster and more efficiently, have greater retention, and feel more positive about the learning experience. Needless to say, that students can just can be grouped to complete a project. There are very specific methods to assure the success of group work, and it is essential that both teachers and students are aware of them [7]. Recently there has been criticism of this process largely as a result of its misuse.

The main reasons to introduce this learning (and teaching) process in a subject could be summarized as follows:

- To promote student learning and academic achievement.
- To increase student retention.
- To enhance student satisfaction with their learning experience.
- To help students develop skills in oral communication.
- To develop students' social skills.
- To promote student self-esteem
- To help to promote positive race relations

Looking at these reasons, it seems that results are quite promising; but a question arises at this point: how do I should get into this teaching/learning process?. Of course, every subject has its own characteristics and particularities; however, cooperative learning studies give a mainline on the implantation of this process and indicate the main subject scopes, which could be categorized as follows:

1) Positive Interdependence:
   - Each group member's efforts are required and indispensable for group success.
   - Each group member has a unique contribution to make within the common effort, because of his or her resources and/or role and task responsibilities.
2) Face-to-face interaction:
   - Orally explaining how to solve problems.
   - Teaching one's knowledge to other.
   - Checking for understanding.
   - Discussing concepts being learned.
   - Connecting present with past learning.
3) Individual & group accountability:
   - Keeping the size of the group small. The smaller the size of the group, the greater the individual accountability may be.
   - Giving an individual test to each student.
   - Randomly examining students orally by calling on one student to present his or her group's work to the teacher (in the presence of the group) or to the entire class.
   - Observing each group and recording the frequency of each member contribution to the group's work.
   - Assigning one student in each group the role of checker. The checker asks other group members to explain the reasoning and rationale, underlying group answers.
   - Having students to teach what they learned to someone else.
4) Interpersonal, small-group skills and social skills must be taught:
   - Leadership.
   - Decision-making.
   - Trust-building.
   - Communication.
   - Conflict-management skills.
5) Group processing:

- Group members discuss how well they are achieving their goals and maintaining effective working relationships.
- Describe what member actions are helpful and not helpful.
- Make decisions about what behaviors to continue or change.

Each particular subject should include and promote all those aspects, although activities should be specified according to subject guidelines.

IV. Subject Overview

In this section, the guideline of Microwave Engineering subject (Transmisión por Soporte Físico 8405-1003) is described in detail, as part of Telecommunication Engineering program, in the University of Jaén (Spain). Microwave Engineering lessons are taught during the second (spring) semester of the fourth course level and its nature is mandatory.

Through this section, a brief description (see Sec. IV-A), together with some motivation reasons, are exposed. In section IV-B, a short guideline of the subject matter is introduced, and an scheme is also shown about the interaction among the other subjects related in the curricula and the Microwave subject.

A. Motivation and description

High frequency technology has arisen during last years, as a consequence of the appearance of new communication systems in the microwave frequency range (300 MHz-300 GHz). Although microwave engineering share many similar aspects with radiofrequency circuits, the particularities of this technology make necessary a deep knowledge of its basis, and also about a set of analysis tools and microwave circuits design procedures.

The basic scope of this subject is to provide the students with the necessary basic knowledge in the analysis and synthesis of analog (passive and also active) microwave circuits. Those aspects include transmission media (waveguides), dispositive and high frequency circuits characterization with S-parameters, analysis and synthesis of active/passive microwave circuits, knowledge about the use of a network vectorial analyzer and a specific CAD microwave software (ADS and Microwave Office).

Apart from the cognitive aspects of this subject, one of the main aims is to stimulate active learning process through collaborative activities and to acquire language skills related with this topic.

B. Subject detailed description

The topics covered by this course are summarized as follows:

1) Introduction to the microwave engineering and the transmission through physical supporting.
2) Previous knowledge: electrodynamics and plane waves.
3) Transmission lines.
4) Impedance matching and tunning.
5) Waveguides.
6) Microwave networks analysis. Power dividers and directional couplers.
7) Microwaves amplifiers and oscillators.
8) Detectors and Mixers. Control and Commutation Circuits.

Laboratory experiments related with the different topics above mentioned are performed by students work groups under the supervision of the lab instructor.

C. Interrelation with some others subjects

The analysis of this relation among the different subjects within the curricula is made in order to know two main aspects: firstly the possible skills learnt in previous subjects and required to initiate the study of Microwave; and secondly the knowledge which is necessary as a prior knowledge for subsequent subjects in the student curricula. This relation is shown in figure 1).

V. Tool description

Thorough this section, a brief review is presented about Software commonly used for cooperative learning (see Sec. V-A). In Sec. V-B a short description about the characteristics of the web-based tool used in Microwave Engineering is made.

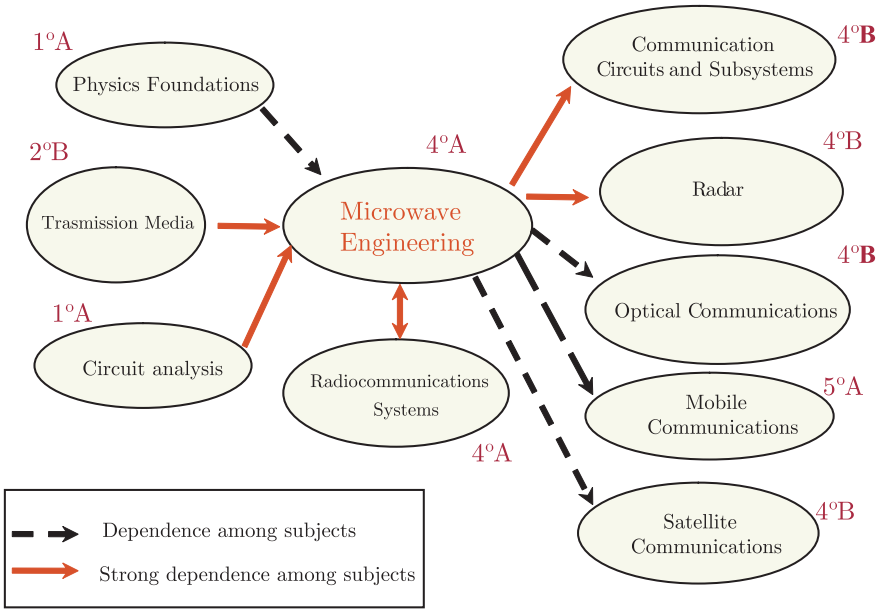

Fig. 1. Interrelation between other subjects of Telecommunication Engineering studies. *A* indicates fall semester and *B* spring semester.

A. Software for Cooperative Work and Cooperative Learning

The new information and communication technologies (ICTs) allow to improve communication and collaboration between equals. Most of the tools specifically designed for cooperative work allow to store, share and manage files, manage teams, and incorporate communications on-line and off-line mechanisms, such as chat, e-mail and forums.

In the last years several educational experiences have been initiated in relation with the instruction and researching using ICTs for collaborative work.

Some software tools specifically designed for cooperative work are:

- BSCW (Basic Support for Cooperative Work)[1]: The BSCW groupware system is based on the notion of a shared workspace allowing the organization and coordination of the collaboritive work within a group. A shared workspace as structured by BSCW consists of a repository for shared information accessible to group members, using a simple user name and password scheme. Everybody can register and create workspace, for cooperation, free of charge, using the public BSCW server. [9][10]
- Microsoft Office Groove[2]: Office Groove is a collaboration application easy to integrate with other popular Microsoft applications. Nevertheless, the main objection of this software concerns its cost.

Some other software for Cooperative Work are GroupLonge[3] and Same-Page eStudio[4].

The universities and other educational centers usually prefer the support of Learning Management System (LMS) to develop collaborative work strategies among their users.

A Learning Management System is a term used to describe software tools that automates the administration of training events. Most of the LMSs manage the log-in of registered users, manage course catalogs, record data from learners, and provide reports to management. A LMS enables an institution to develop electronic learning materials for students, to offer these courses electronically to them, to test and evaluate the students electronically, and to generate electronically student databases in which student' results and progress can be charted.

In the context of the LMSs, cooperative learning refers to a collection of tools that can be used by the students to assist, or be assisted by others. Such tools include a chat, a discussion threads and applications sharing.

Some very popular LMS platforms are:

[1]url: http://public.bscw.de/
[2]url: http://office.microsoft.com/en-us/groove/
[3]url: http://grouplounge.net/
[4]url: http://www.same-page.com/

- Moodle[5]: Open Source
- Claroline[6]: Open Source
- ILIAS[7]: Open Source
- Dokeos[8]: Open Source
- Blackboard[9]: Commercial LMS platform.

B. Virtual learning platform

ILIAS a web-based LMS was the platform used in this experience. This platform is provided provided by the University of Jaén. Most of the curricula subjects use ILIAS, but just as a repository space to publish certain subject materials. Therefore, the students and lectures are familiar with this system, and this is the main reason to chose this platform to support collaborative work in Microwave Engineering course.

ILIAS consists of tools for learning, authoring, information access and co-operative work, thus presenting an integrated environment for learning and teaching on the Internet. Using this platform lectures of a course can create in common material and publish them. Furthermore students can work through this platform and communicate to each other or to their lecturers.

The main tools of ILIAS used to promote collaborative work are:

- Forums. The lecturers can create separate forums for small groups. Forums can be explored by date or topics. The Posts can also include attachments.
- E-mail. It provides internal e-mail service. Students can use this tool to send e-mails to other members individually or in groups.
- Chat. This synchronous communication tool is not very suitable to exchange contents with math notation, but may be suitable if it is used together with the e-mail tool.
- Work group: Lecturers and students can assign students into different groups. Each group can have its own discussion forum, file repository and chat room.

The main characteristics of the Forum are:

- Messages are composed, shared and organized during specifiable periods of time.
- Students who are identified have permissions associated with them (e.g. defining them as groups/subgroups).
- Messages can identify new topics, reply (recursively) to previous messages, and be thus hierarchically organized or structured.

During our experience the Forum has become the most popular tool among students. Student groups have used this asynchronous communication way to share auto-evaluation question related with the topics covered by the subject (see Fig. 2).

Other asynchronous communication tool offered by ILIAS is an internal e-mail service. The groups have mainly used the e-mail service for self-organization tasks and as a mechanism of communication with the lecturers. (see Fig. 3).

The Chat tool has not been used very often by the students groups because the found difficult to deal with the topics about Microwave Eng. using common languages typically used in a chat room (see Fig. 4).

VI. Results and Conclusion

The experience has been evaluated during the last two academic years. Students were free to choose collaborative work supported by the Virtual Learning Platform or not. The total amount of students that adopted the cooperative learning methodology (C group: Cooperative) were 28 and the total amount of students that rejected accepting cooperative learning methodology were 30 (NC group: Non Cooperative).

The process of evaluation was the same for both group of students. The only difference was that the lab-projects were adapted to the number of members in the work group (composed by five member). The lab-projects were evaluated through a report. Students of both groups (groups C and NC) fulfilled this report when all the sessions devoted to a lab project were completed. In addition, a final test involving questions to choose among different options and problems is an important part of the evaluation process, being necessary achieve 50% in the final test to pass the course.

Fig. 5 show the result of the experience.

[5]url: http://moodle.org/
[6]url: http://www.claroline.net/
[7]url: http://www.ilias.de/
[8]url: http://www.dokeos.com/
[9]url: http://www.blackboard.com/

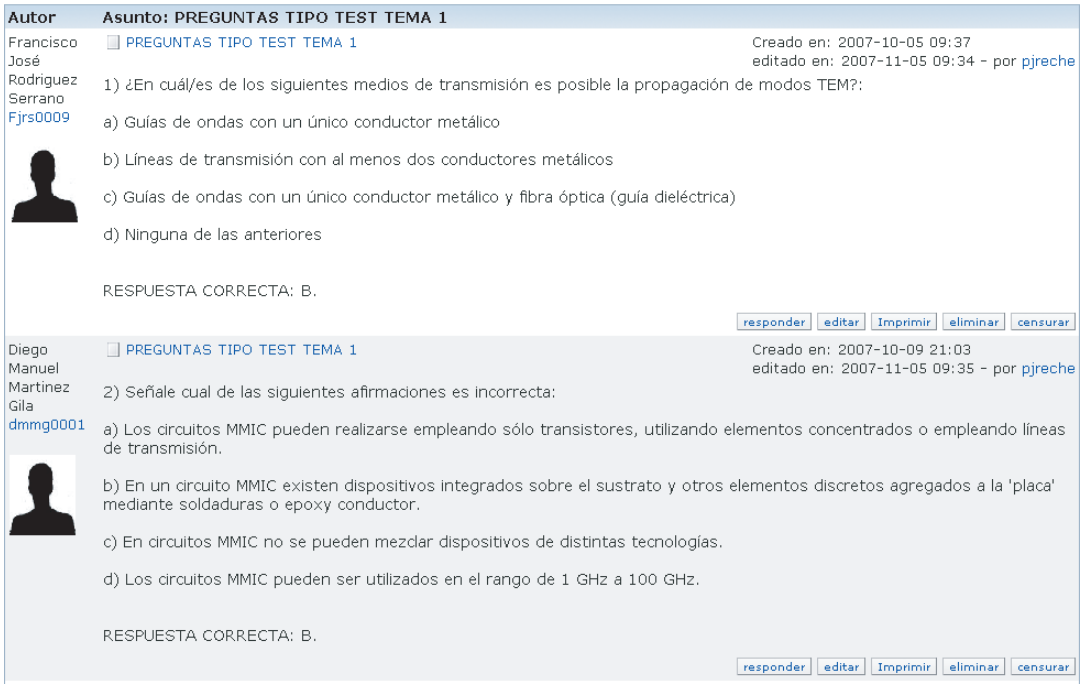

Fig. 2. A screenshot showing a thread in a group forum.

The evaluation of this experience consisted in to compute the percentage of students of both groups that got involved in this collaborative project attending to three categories. These three categories and the results obtained for both groups are shown in figure In Fig. 5. The category FAIL shows the number of student that failed the evaluation process although they completed it. The students considered in PASS category were those who pass the evaluation process completely. Finally, the category named as NON EVALUATED considered the percentage of students that did not complete the course.

As can be seen in figure 5, results about the percentage of students who reached or not the minimum targets established in order to pass the subject were worst in the learning group without cooperative work. Nevertheless, the main difference between groups arose in the percentage of students who followed the evaluation process until its completion.

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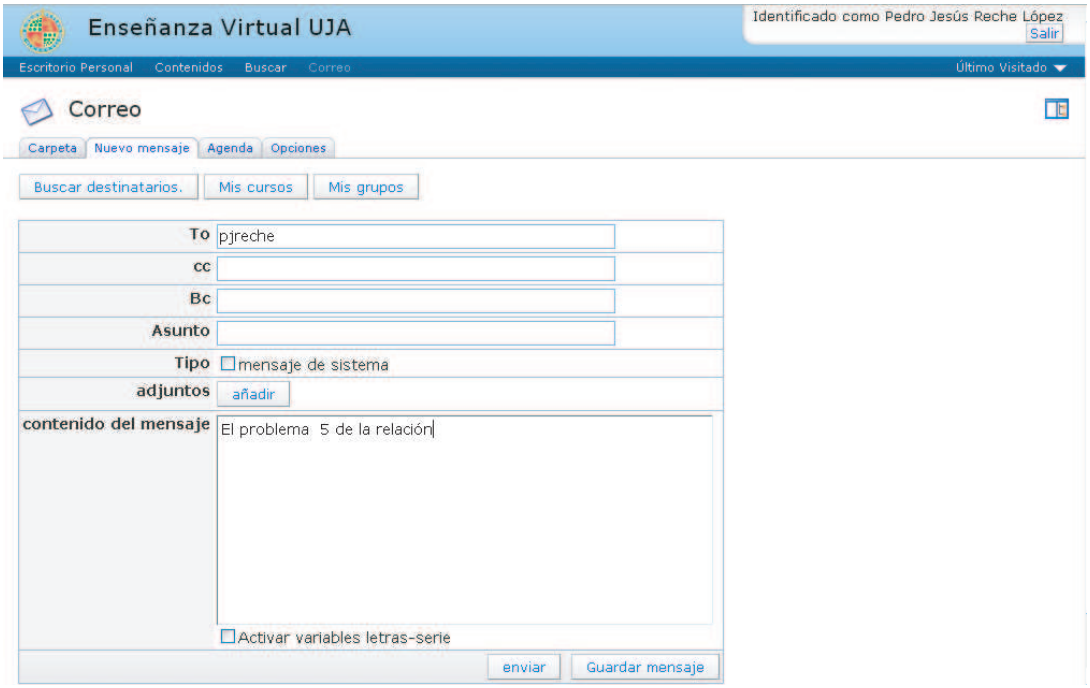

Fig. 3. A screenshot showing e-mail tool.

Fig. 4. A screenshot showing a chat room for a work group.

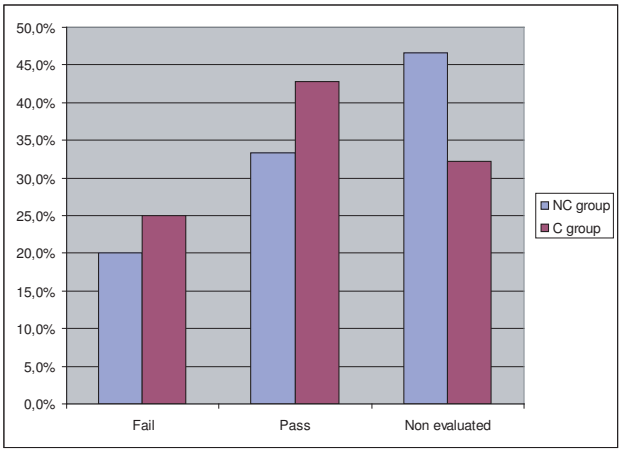

Fig. 5. Results of the experience.