Approach to Teaching Communications Systems by Collaborative Learning. Student Perceptions in the application of Problem-Based Learning.

Analysis of results

B. Sainz-de Abajo, I. de la Torre-Díez,
M. López-Coronado, F.J. Díaz-Pernas,
J.F. Díez-Higuera, M. Antón-Rodríguez
Department of Signal Theory and Communications.
Telecommunications Technical School (ETSIT).UVA.
Valladolid, Spain
{beasai, isator, miglop, pacper, josdie, mirant}@tel.uva.es

E. García-Salcines, C. de Castro-Lozano
Department of Computer Science.
University of Cordoba
Cordoba, Spain
{egsalcines, ma1caloc}@uco.es

Abstract—**This document reflects the results of the study at the end of the course, which justify how the application of problem-based learning and collaborative learning help the student to take on board in the most appropriate way the study material. An analysis of the results of the surveys carried out amongst those students learning Communication Systems in Industrial Technical Engineering was undertaken, in order to evaluate whether the application of Problem-Based Learning (PBL) methodology together with Collaborative Learning (CL) was likely to improve the rate of development of their ability indispensable in today´s business world, and also to achieve those objectives set out in the course. By far the majority of students showed a very positive attitude towards this methodology, their objections being very limited. A comparison was carried out with the results of those courses of a similar nature at the University of Cordoba, as was the attitude of the students towards this new methodology, with very comparable results.**

Keywords- collaborative learning, learning management system (LMS), problem-based learning (PBL), communication system, education.

I. INTRODUCTION

Despite educational methods have changed over the years according to the results (successes and failures) that the system imposes, as teachers we must find a way of looking at the challenges our future engineers face, using new ideas, developing their creativity in such a way as it improves their own knowledge and that they learn the study material at the same time as resolving a problem or proposed project. If, to this way of constructing knowledge using the problem-based learning method (PBL), the achievements of which have been collected in various bibliographical reports, we add collaborative learning to develop the intellectual capacity and the social skills of our students through interaction with their colleagues, as teachers we will have achieved two very worthy objectives: that of giving them knowledge and of providing them with a range of abilities for their future professional development.

Although it was in the Faculty of Health Sciences of the University of McMaster, that the new educational system now known as PBL was established in the 60s [1], this methodology has since been implemented in both primary and secondary education, given its demonstrable efficiency, thanks to the numerous publications that praise the positive effects of its implementation in engineering courses [2-4].

The use of Moodle, a learning management system (LMS) adapted to the course, contributes to interactivity and the meeting place of our students outside of the classroom, so important for this cooperative learning, the philosophy of which is based on development and analysis.

II. THE MAIN OBJETIVE

This article is based on the analysis of results obtained from the students of the final Industrial Engineering course, following the application of the teaching method Problem-Based Learning (PBL) using Collaborative Learning (CL).

Communication Systems subject is elective subject undertaken during the last term of the last year of the Industrial Engineering, Industrial Electronic speciality, degree. Its aim is to analyse different systems for high speed Internet accessing. Most of the students arrive with any knowledge of this matter, due to they come from the area of Industrial Electronics.

Due to the use of both the PBL and the CL, the students develop the learning process in groups by the project solving, achieving the subject goals by experimenting and searching information sources. This methodology helps the students to understand and assimilate the knowledge through the use of basic assumptions versus the conventional method used previously mainly based on the master class. In the PBL method, the problem is first presented to identify the learning requirements and then it is essential the information-gathering

process to, finally, return to the problem. Hence, the learning process is reversed. The foundations of the PBL methodology are the Cooperative Learning and the Constructivism, where the students acquire skills through problem solving.

The advent of the modern knowledge society requires changes in educational processes [5]. Everything seems to indicate that the PBL method is a better way of imparting education in communications systems, or even technology in general. PBL course students learn social skills through interaction in small groups, how to identify and define a problem, and how to look for and filter out relevant information [6]. PBL promotes engagement in meaningful learning and cooperation among students [7]. In the same way, collaborative learning changes the structure of learning in the classroom, permits interactions and makes easier and develops basics skills such as dialogue and solidarity, amongst other things. The methodology and its application for education in communication systems will be discussed in this paper.

Despite a wide-ranging bibliography which defends the positive results of the application of these methodologies, as investigators we are bond to question whether it is the most appropriate method for our engineering students, given the recent nature of its implementation in the course and the fact that as human beings we are naturally slow to adopt new ideas. Because of this, using a series of surveys, we managed to discover how people felt about the implementation of this method compared to traditional teaching methods, taking into account the final results of the evaluations of knowledge gained and cross-referencing abilities.

III. METHODOLOGICAL APPROACH

A survey at the end of the course showed that students were satisfied with the pedagogical approach. These results are based in a questionnaire with four items, where the students are asked about the effectiveness of the method applied during the semester versus the traditional method (master class) to attain the subject goals. The interrogated students were a total of 22. The contribution was compulsory and anonymous. The students take an average of 10 minutes to answer the questionnaire. The opinion of the students, allows us to tell whether this methodological practice is the most appropriate for the teaching development of the communication systems course, taking into account not only the assessment of the students involved, but also the final academic results of the students compared with the course records, which allows us to demonstrate objectively how the application of this methodology obtains better learning results, not only at an academic level, but also in the way the student is more involved in the learning programme and gets from it greater personal satisfaction. The knowledge evaluation carried out on the students, in terms of end exams, shows that there was a significant difference in the knowledge gain. The skill sets acquired were definitely greater than those acquired by the students of traditional education as was demonstrated by the results of the skill test conducted at the end of the course.

Following analysis of the observations made by the students, we can divide the evaluation of the methodology into

Very Positive, Positive and Negative. Table I shows the results with the corresponding percentages.

Following are some of the comments made by the students in defense or rejection of the new methodology (Table II).

IV. ACADEMIC RESULTS AND OBSERVATIONS

Many questions have arisen and for the most part they have been assessed favourably. Equally, a small percentage shows up of students who continue preferring to develop their work in an individual way, believing that their final results will be better. The rejection by some students of the methodology in the initial phase of its application has already been described by Felder [8].

Looking at these results it can be claimed that despite the recent application of the method in the course, the Very Positive evaluation is overwhelming, in the students words "interesting", "engaging", "dynamic" working in a collaborative way in the development of the PBL methodology, favouring the exchange of opinions with those with whom they had not previously worked, given that the those people making up the groups had been chosen arbitrarily by the professor. Many underline the importance of working in a group as being a stepping stone in the way they will inevitably develop their professional careers.

TABLE I. PERCENTAGE OF EVALUATIONS

	Percentage
Very positive	63,6%
Positive	27,3%
Negative	9,1%
Total	100%

TABLE II. ARGUMENTS FOR AND AGAINST THE APPLICATION OF THE METHOD ACCORDING TO THE POSITION OF THE STUDENT.

	Arguments for and against
Very positive (63,6%)	It is an interesting method which allows for the expression of contrasting opinions, unlike traditional teaching methods where the opinion of the professor is the final word and we the students must accept that. It is more engaging being able to exchange ideas and participate. The class is more dynamic. It is a good method for interchanging ideas. It allows you to listen to the opinions of others and compare ideas. It makes you think and it is easier to retain information. Because you work in a group, the class is more active. It brings benefits such as being able to work with class-mates. One learns the opinions and proposals of ones class-mates. It is easier to understand certain things when a class-mate explains them.

April 14-16, 2010, Madrid, SPAIN
IEEE EDUCON Education Engineering 2010 – The Future of Global Learning Engineering Education

1296

	Working as a team has made it easier to resolve problems. It allows one to share the different view-points of the whole gr oup, to lear n to fit in and to work as a team. I would do the same thing again in other courses.
Positive (27,3%)	It is a ver y good m ethodology but sometimes one works better alone. Working as a team is good when all of the group members pull together. It works well when there are few people in the group, but it is better working alone when the groups ar e very big, given that it is much harder to make headway when so many have to be in agreement. Not all the gr oup members put in the sam e amount of effort. It is a good method, but not necessarily for the entire cour se. Sometimes it is good to have a traditional theory class.
Negative (9,1%)	I prefer working alone. I don´t feel comfortable. I prefer the traditional method.

The students point out the fact that working in a group and with their classmates explaining certain concepts (and therefore those th ey consid er as equ als), helps with understanding and retention.

There is a certain group of students who, despite showing a positive reacti on to this type of apprenticeship, allege that the application of t his methodology requires more time to develop the activity than that of traditional teaching m ethods. Ot hers claim t hat the st udent o nly real ly underst ands t he part t hey have worked on, which shows that they do not understand the philosophy of this methodology, the point of which is that all the stu dents ach ieve th e o bjectives la id o ut in th e co urse through t he development of t he pro blems or p rojects put forward. The fact that no one component pa rt of the g roup is able to provide an a dequate solution to the problem may be a negative facto r in th e development o f th e wo rk. Finally, th e lack of invol vement of some of the me mbers may also unbalance the work of the other component parts.

Amongst the negative opinions, that which stands out for a small minority of students is th e refusal to a ccept the changes in methodology and the simple fact that the implementation of PBL i nvolves dedicating m ore t ime to and bei ng dependent upon a gr oup of people who perhaps are no t committed to the activity, undermining the end results.

Following we show the academic results compared with those o f the t wo previous courses (see Fi gure 1, 2 an d 3), i n order to h ighlight th e effectiv eness of th e application o f the method in a teaching environm ent, given that the ultimate purpose of p ursuing i ts appl ication i s t o s how t he l evel o f effectiveness of this methodology. It is important to point out

that th e en rolment n umber were 2 0 in 200 6/2007 an d 23 in 2007/2008.
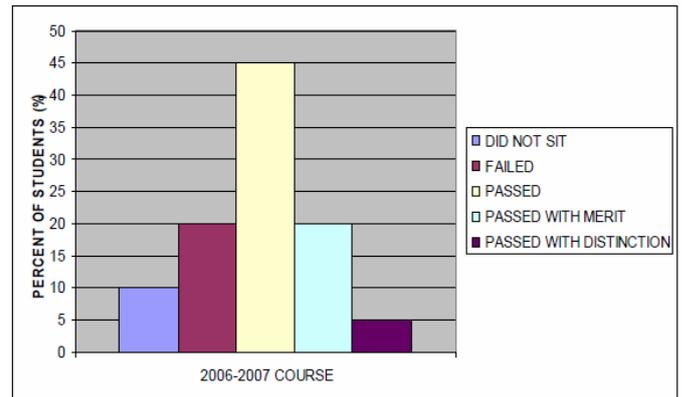

Figure 1.   Results of the student evaluation: overall grades (2006-2007). University of Valladolid, Spain
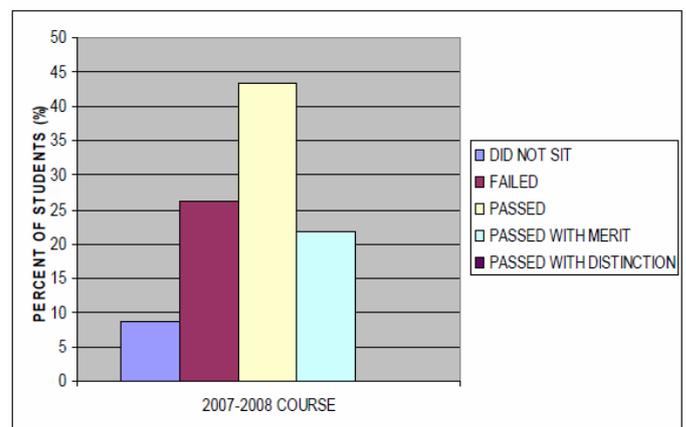

Figure 2.   Results of the student evaluation: overall grades (2007-2008). University of Valladolid, Spain
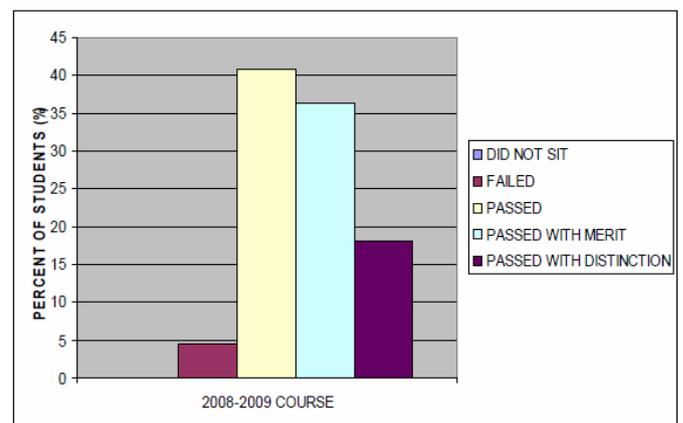

Figure 3.   Results of student evaluation: overall grades (2008-2009). University of Valladolid, Spain

V. CONCLUSIONS

Thus, th is article reflec ts th e resu lts o f th e stu dy wh ich justify ho w t he appl ication of problem-based l earning an d collaborative learni ng help t he student t o t ake on b oard i n the most appro priate way t he st udy material and i mprove t heir social skills. T he social skills gai ning were also observe d by the students. They ad mit th rough the s urvey that the g roup working let th em sh are, in tegrate, and ev en learn t to work in group and to listen to others, better communicating their ideas.

From this information it is obvious the need for a change in the conception of the teaching-apprenticeship process, although this d oes n ot necessarily imply th at the tr aditional clas sroom environment no longer has its pl ace. What stands out from the gathering of data is h ow th e joint app lication of t hese methodologies is generally well -received by the student. The fact that the surveys were carri ed out anonymously leads to the belief th at they are v alid an d th e fact that the grades of the students have im proved co nsiderably, confi rms once agai n what t he st udies have demonstrated in ac cordance with the application of t his methodology: i ts effect iveness i n t he appropriate devel opment of concept ual an d cross -referencing skills of those students taking engineering degrees.

It is also wo rth no ting that the statis tics o f this stu dy h ave been compared with those of degree courses of a similar nature in the field of engineering, of the department of computing and numeric analysis of the University of Cordoba, where the PBL methodology has been a pplied in a si milar way, together with collaborative l earning. We a ppreciate an i mprovement in t he final grades in both Universities (see Figure 4 and 5).

We can al so see a hi gh l evel of sat isfaction amongst those students q uestioned abo ut t he benefi ts of this new way of acquiring knowledge.

We b elieve it would be in teresting to ex tend th is stud y to different courses and degree subjects, with the idea of soliciting the opi nion of t he st udents o f t his t echnique for t he different subjects of the study, given that it may not be so easy to apply.

The results could differ accordi ng to the contents, adapting the most appropriate methodologies to each course to gain the necessary ski lls. Only by finding the most appropriate method using the feedback of the interested parties, we will b e able to obtain t he bes t resul ts and the hi ghest l evel of sat isfaction amongst students. As professors we must take into account the opinions of the students with respect to the methodology which sparks the most interest, motivates and improves results.

REFERENCES

[1] H. Barr ows. "Pr oblem-Based lear ning in medicine and bey ond: A br ief overview". In L . Wilkerson, W. H. Gijselaer s (eds) Br inging Problem-Based L earning to Higher E ducation: Theory and Practi ce, San Francisco: Jossey-Bass Publishers, 1996. pp. 3-12.

[2] M. D. Nor thwood and D. O. No rthwood, "Pr oblem-based lear ning (PBL): F rom the health sci ences to engineer ing to value- added in workplace," *Global J. Eng. Educ.*, vol. 7, no. 2, pp. 157–164, 2003.
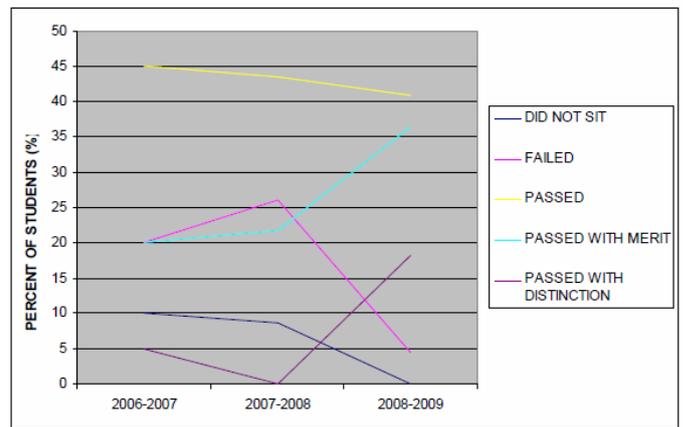
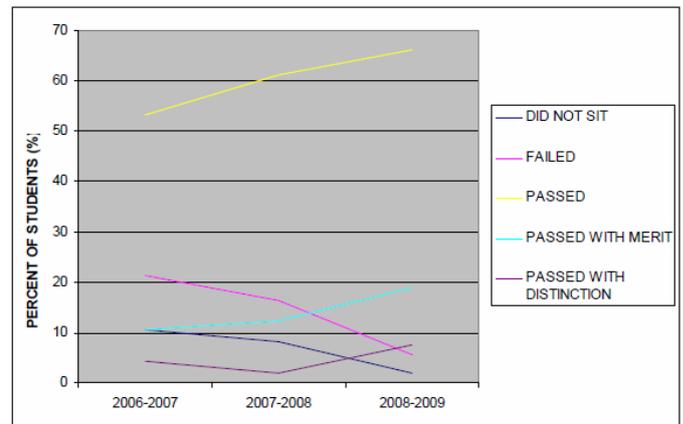Figure 4. Improvement in the final grades. University of Valladolid

Figure 5. Improvement in the final grades. University of Cordoba

[3] D. L. Maskell a nd P. J. Grabau , " A multidisciplinary cooperative problem-based lear ning appr oach to em bedded sy stems design," IEEE Trans. Educ., vol. 41, no. 2, pp. 101–103, May 1998.

[4] R. Garc ía, F. Díaz, S. Vi cente and A. Linares, "An eL earning Standar d Approach for Sup porting PBL in Co mputer Engineering," IEEE Trans. Educ., vol. 52, no. 3, pp. 328–339, Aug. 2009.

[5] N. Hoic- Bozic, V. M ornar and I. Boticki, "A Blended L earning Approach to Course Design and I mplementation," IEEE T rans. Educ., vol. 52, no. 1, pp. 19-30, Feb. 2009.

[6] L. R. J. Costa, M .Honkala and A. Lehtovuori, "Applying the Pr oblem-Based Learning Approach to Teach Elementary Circuit Analysis," IEEE Trans. Educ., vol. 50, no.1, pp. 41-48, Feb. 2007.

[7] Y. Miao and J. Haake, "Supporting Pr oblem based L earning by a Collaborative Vir tual Environment: A Cooper ative Hy permedia Approach," hicss, vol. 1, pp. 1052, 34th Annual Hawaii I nternational Conference on System Sciences (HICSS-34)-vol. 1, 2001.

[8] R. Felder, "W e Never Said It Would Be E asy". *Chemical Engineering Education,* vol.29, pp.32-33, 1995.